

# 2008 Montana State University Research Plan of Work

## I. Plan Overview

### 1. Brief Summary about Plan Of Work

Montana State University 2008 — 2012 Plan of Work

Situation: Montana is a rural state with a land area of 93 million acres and a population of 940,000. Farms and ranches represent 64% of the land in Montana. Montana ranks 2nd in the U.S. in the number of acres devoted to agricultural enterprises with crop and livestock industry annual cash receipts over \$3 billion. Montana ranks 2nd in the production of barley, 3rd in wheat, and 5th in sugar beets. With the support of advances in Montana State University (MSU) research, Montana has moved up in the ranking of specialty crop production to 1st in Austrian winter peas, 2nd in dry edible peas, 2nd in flaxseed, 2nd in lentils, and 3rd in canola. An increase in organic wheat, barley, and Kamut grain demonstrates new initiatives. In 2005, Montana had 28,000 farms and ranches with 60 million acres dedicated to agriculture. Over nine million acres were cropped and the remaining 51 million acres were grazed or used for other agricultural purposes. Small grains represented about 73% of the cropped acres, alfalfa and other hay 10%, and other crops 17%. Wheat and barley represent about 25% of the total agricultural receipts for the state. Over 85% of Montana's raw commodities are exported out of the state. Montana moved up to 3rd among states exporting wheat and products for fiscal year 2005. Montana ranks 12th among U.S. states in the production of cattle and ranks 6th in the production of sheep and lambs. Cattle and calves represent over 86% of the livestock receipts for the state and 48% of the total agricultural receipts for the state.

The College of Agriculture (COA) (six departments and one division) at MSU is headquartered in Bozeman, MT, and is comprised of the Montana Agricultural Experiment Station (MAES) and the College's academic programs (5 departments and one division) in undergraduate and graduate studies. The MAES system is a network of eight Agricultural Research Centers, four farms, and two collaborative research programs with USDA-ARS. In addition, Extension Specialists are in the COA in five of seven units. Extension efforts are generally reported separately.

Expanded partnerships include the Montana Extension Service, MSU-Billings, MSU-College of Technology at Great Falls, MSU-Northern at Havre, the 1994 Land Grant tribal colleges, and other state, federal and private institutions in Montana and the region (e.g. North Dakota State University, South Dakota State University, University of Idaho, and the University of Wyoming). Native Americans represent the largest group of potentially underserved citizens in Montana. MSU works with tribal councils, colleges in the Rocky Mountain region, and educators to provide programs and educational opportunities for this group of Montana citizens.

Priorities: As a result of the stakeholder input meetings, focus groups and general interactions, MAES received specific suggestions and ongoing support for research and outreach activities. These were:

- Add value to Montana's high quality crop and livestock products
- Create new business opportunities for rural communities
- Develop higher yielding solid stem wheat varieties
- Enhance the development of agronomically sound hard white wheats
- Expand research on agricultural and natural resource interactions
- Explore alternative and new crops
- Improve beef production practices and use genetics to improve herds
- Increase research programs on alternative energy sources, including crops for biofuel production
- Provide better marketing of applied research results

Other areas of research that received responses in the high priority rating were animal and livestock diseases, crop production and management, livestock production and management, natural resources, noxious weed management, nutrition and health, and range production and management. These results will likely continue to influence MAES research priority areas in the next decade.

Input Section: Stakeholder input has been solicited in the strategic planning process and is continually reaffirmed as programs are developed, implemented, and changed and as dollars are allocated and reallocated. The COA and MAES have 27 advisory committees and boards with more than 250 members. These include: The Animal Biosciences Complex Board, Biobased Product Institute, Center for Invasive Plant Management Board, Center for Invasive Plant Management Science Advisory Council, Central Agricultural Research Center Advisory Committee, Eastern Agricultural Research Center Advisory Committee, Foundation Seed Advisory Committee, Joe Skeen Institute for Rangeland Restoration, MAES State Advisory Council, Mint Committee, Montana Agricultural Innovation Center Board, Montana Beef Advisory Committee, Montana Beef Network Advisory Committee, Montana Farmers Union, Montana Pulse Growers Association, Montana Seed Growers Association Board, Montana Wool Growers Advisory Committee, Northern Agricultural Research Center Advisory Committee, Northwest and Western Agricultural Research Centers Advisory Committee, Organic Certification Association of Montana, Potato Certification Board, Southern Agricultural Research Center Advisory Committee, Thermal Biology Institute Scientific Advisory Board, Undaunted Stewardship Guidance

Council, Variety Release and Recommendation Committee, and Western Triangle Advisory Committee. Members of these committees represent farmers and ranchers, tribal councils, county extension agents, financial organizations, communities, scientists, agricultural educators, private citizens, small businesses, conservation groups, reservation groups, and agricultural organizations. The COA and its MAES faculty respond to input from these stakeholders and state/national/international trends by continually developing new programs.

Inputs/Funding: The source of funds contributing to the research conducted by MAES faculty include, but are not limited to: BIA, BLM, Canadian Provinces, conservation and wildlife groups, Montana Board of Research and Commercialization Technology, Montana crop and animal agricultural groups, Montana Department of Agriculture, Montana Department of Environmental Quality, Montana Department of Natural Resources and Conservation, Montana Department of Transportation, Montana Fertilizer Advisory Committee, Montana Noxious Weed Trust Fund, Montana Wheat and Barley Committee, NASA, NIH, NRCS, other states, overhead investments from sponsored programs, private donations, private industry, the State of Montana, USDA, USEPA, and USFS.

Outcomes and Impacts:

Enhance Economically Viable and Sustainable Agricultural Systems

- Contribute to commodity and product marketing and economic development
- Create comprehensive programs that address issues and problems associated with plant and animal systems
- Develop competitive, sustainable, and viable plant and animal systems
- Enhance our understanding of rural, urban, and disturbed landscapes
- Expand stewardship practices
- Foster the development of value-added biobased products
- Improve food safety and quality
- Improve plant and animal health through integrated pest management (IPM) and other sustainable practices
- Improve the fundamental understanding of plant and animal biology

Strengthen the Quality of Life for Montana and Its People:

- Create opportunities for undergraduate and graduate students to engage in research
- Develop partnerships to enhance business and community development
- Facilitate the development of educational programs and new delivery systems
- Improve recruitment and retention of students

Each of the seven agricultural research centers holds annual field days in cooperation with USDA-ARS for the presentation of research information through outreach activities and to collect input on new research directions. These field days are attended by agricultural clientele, elected officials, and the general public with participation by faculty, staff, and students.

Program Areas

Animal Health

Situation: Maintaining high quality meat, milk, and fiber products from Montana livestock is a major focus of research. Losses due to environmental stresses, diseases, and mortality create the need for improved understanding of the factors affecting Montana livestock. Promoting and maintaining animal health (cattle, sheep, and wildlife) has led to advances in genetics, performance, and reproduction. By understanding immune systems and parasite development in livestock, and by developing novel genes and new biochemical routes of activity for drugs and vaccines, economically important diseases such as coccidiosis, shipping fever, and brucellosis may be managed more effectively. Researchers continue to investigate protein antigens for prevention of equine strangles in horses and to investigate the effects insects have on disease transmission. A focus on disease management, reproduction, and carcass traits will help ensure that Montana meat products continue to maintain the highest standards for the meat industry and consumers.

Priorities: Producing high quality animals and obtaining the highest profit potential are essential for Montana to maintain or exceed its current ranking in the national cattle and sheep industry. Disease management and research continue to be the primary focus. Research in targeted mutagenesis of cells in cattle will make milk and beef production more efficient. MAES researchers collaborated to develop a functional genomics program to study bovine immune cells. Ongoing vaccine trials are now underway with Texas A&M researchers to study brucellosis in bison. Research is continuing in collaborations with researchers at the University of Montana and the NIH Rocky Mountain Lab to form a center for studying emerging infectious diseases in wildlife and livestock. The development and implementation of new management protocols and/or pharmaceutical and nutritional regimens that will increase the fertility of domestic ruminants in the Western region by increasing conception and reducing embryo and fetal loss are multistate collaborative goals. Understanding the breeding characteristics and activity of bulls and cows will lead to improved efficiency in controlling the breeding process.

Input: Stakeholder input has been solicited in the strategic planning process and continues throughout as programs are developed,

implemented, and changed as dollars are allocated and reallocated. Valuable input has come from The Animal Biosciences Complex Board, Central Agricultural Research Center Advisory Committee, Montana Beef Advisory Committee, Montana Beef Network Advisory Committee, Montana Wool Growers Advisory Committee, USDA, ARS, and other organizations that have a vital interest in livestock production in Montana.

**Research Activities:** There are no efficacious brucellosis vaccines for bison and current vaccines are only partially effective in livestock. MSU studies are designed to develop new subunit and live brucellosis vaccines that will effectively protect bison and cattle against brucellosis. Additional bison studies are evaluating antimicrobial proteins that are present in bison neutrophils and their activity against several relevant pathogens. A better understanding of these proteins could potentially lead to practical applications to controlling infectious disease in bison and other wildlife while reducing concerns of cattle producers in areas near Yellowstone National Park.

Cattle research focuses on disease control, reproductive enhancement, and animal productivity. MSU studies have been designed to optimize mucosal and systemic antibody responses in heifers to provide passive immunity to newborn calves that are especially susceptible to scours. Vaccine development for ruminants consists largely of inactivating the pathogen and administering the vaccine without concern to possible side effects or efficacy. MSU is testing a mucosal vaccine delivery system to provide the basis for a future generation of ruminant vaccines. A successful outcome from these studies will facilitate development of new livestock vaccines. Calves are also susceptible to pneumonia after weaning and shipping. Investigating the mechanisms by which calves resist lung infections will help us better understand why these calves become susceptible to infection.

Programs are in place to investigate vaccines for rotavirus, which is the major viral cause of diarrhea in cattle and costs the industry \$500 million per year. Prion diseases, such as bovine spongiform encephalopathy (BSE) in cattle, scrapie in sheep, and chronic wasting disease (CWD) in deer and elk, are caused by novel infectious agents and results in a fatal degeneration of the central nervous system. Research is being conducted to define the pathway of prion agent infection of skeletal muscle following oral prion infection. These studies can improve our understanding of how the prion agent spreads within a host in order to infect peripheral tissues such as muscle. Mycobacterium avium ssp. paratuberculosis infects an estimated 22% of commercial beef and dairy cattle herds in the U.S. and results in production losses of nearly \$250 million annually. Research continues in the development of vaccines for M. paratuberculosis that is the causative agent of Johne's disease, an important animal pathogen that has also been implicated in human disease. The annual cost of coccidiosis to livestock producers is in the hundreds of million of dollars. Despite improved dairy herd management, mastitis still represents one of the most costly diseases of the dairy industry. MSU researchers are seeking to develop a better understanding of mammary defense mechanisms in order to establish effective therapeutic approaches.

Equine strangles continues to be a problem to horse health and industry, despite the widespread use of commercial vaccines. Researchers are investigating the roles of antigenic cell surface proteins of S. equi in their contribution to disease in horses with the ultimate goal of developing vaccines.

The herpesviruses are a group of viruses that establish life-long, persistent infections in a wide range of animals, including chickens, horses, pigs, catfish, and cattle. MSU is working to develop a universal strategy for developing improved live vaccines against herpesviruses.

#### Agronomic and Forage Crops

**Situation:** Small grains, forages, and short season specialty crops make up the bulk of the cropping activity in Montana. Our long-term strategies are designed to make Montana agricultural products more desirable in U.S. and world markets. High-value and alternative crop production for eastern Montana involves close collaboration between research and extension faculty in Montana and North Dakota. Sugar beets are one of the highest value cash row crops now grown in eastern Montana. The industry provides many production, processing, refinement and marketing jobs to the area. The development of higher yielding varieties and the establishment of new value-added crops are priorities among agronomic researchers. The limited water resources and growing season available to producers requires researchers to be innovative in their approach to crop and pest management. Higher disease and insect resistance in wheat and barley, greater nutritional value for forages, and more efficient use of natural resources, especially water, are key priorities.

**Priorities:** One of the major environmental challenges in Montana is to create better rangeland management in concert with the preservation of riparian habitats, wildlife, and clean water. Characterization and understanding of the complex interactive components will lead to improved soil, plant, and water resources in those ecosystems. Projects in agronomic and forage research at MSU often contain objectives that interconnect with objectives in plant and animal genomics, and biobased and sustainable agriculture. Montana consistently grows high quality, disease-free seed potatoes for export to other potato producing areas. Maintaining this status and exploring other sustainable disease-free seed and production crops are priorities. Developing projects that meet more than one objective provides increased value to our stakeholders.

**Inputs:** The management of rangeland for grazing livestock continues to be a priority among Montana producers. Summaries of

survey information from the Montana Weed Coordinators have identified critical local research needs on the management of invasive plants on private, public, and agency lands. This has led to new state funding initiatives and research and education alignment with the multi-agency and citizen supported Montana Weed Management Plan. The Montana Wheat and Barley Committee provides financial support to MAES scientists through a competitive grant process. This financial support helps direct research programs in spring/winter wheat, barley, cereal grain quality, IPM practices, and interactions in small grains and crop rotations. The Montana Noxious Weed Trust Fund provides funds for community watershed cooperative projects and for competitive education and research funds for COA/MAES scientists.

**Research Activities:** Surveys at Montana farm conferences indicated a strong interest in diversified crop rotations. Crop diversity studies continue to show promise for increasing on-farm receipts while reducing a monoculture of small grains. Winter and spring peas, canola, corn, lentil, mustard, sunflower, triticale, and chickpea are included in long-term rotation studies. Pulse crop production dramatically increased to 350,000 acres in 2005 due, in part, to our research. Research into new crops such as dwarf and slow-growing lawn grasses, native ornamental flowers, essential oils, and crops for natural rubber production and bio-energy are examples of research that will provide opportunities for growers and their communities. An increased focus on the production of geranium, thyme, and sage is being made for transitioning from peppermint oil production to other essential oils. Barley varieties with improved feed quality could provide sustainable seed and grain markets for regional grain producers and marketing advantages to regional beef producers. Additionally, the use of reduced tillage and no-till systems are being evaluated to demonstrate their sustainability.

Studies in precision agriculture have led to the development of a tool for a rapid nondestructive characterization of soils for a variety of environmental and agricultural applications. This process could dramatically increase the availability of soil data for monitoring carbon sequestration in agricultural lands.

Livestock grazing practices are receiving increasing attention because of perceived negative impacts on soils, biodiversity, and water quality. By determining the grazing behavior and the subsequent growth of cattle, decisions can be made on the need for supplemental feed over winter months based on models established in the research. An evaluation of the effectiveness of livestock distribution practices on grazed watersheds is a part of an ongoing three-state project that includes MSU, University of California (Davis), and Oregon State University and the USDA-ARS. Research from this project has shown the potential to manipulate cattle grazing patterns to protect and improve fishery and wildlife habitat. Research from Montana suggests that herding can also be a very effective approach to protecting riparian areas. The combination of herding and strategic supplement placement can potentially focus cattle grazing on upland areas that typically receive little use. Because ranching enterprises make major contributions to wildlife habitat, their viability is important to the preservation of elk and elk habitat.

The ecological role of shrubs is not well understood although they are critical in land management decision-making. Grazing and fire recovery in rangelands are priority issues to be studied in Montana, Yellowstone National Park and Wyoming. Determining successional patterns of sagebrush communities and their interaction with wildlife will help determine priorities for natural resource managers.

#### Biobased Products and Processing

**Situation:** The future of Montana's agricultural economy depends on maximizing net returns per acre or per animal unit, while using resources efficiently. It is increasingly important to add value to raw agricultural commodities and processed food products in order to capture increased value. MSU initiatives in the development of sustainable energy alternatives provide opportunities for creating renewable biobased products from Montana crops. The goal of the Biobased Products Institute (BPI) is to build a biobased economy that provides in-state manufacturing, product development, rural development, job opportunities, and an opportunity to increase farm and ranch incomes.

**Priorities:** The revitalization of agriculture and rural communities in Montana is essential for the state's economic sustainability and competitiveness. The objective of BPI is to develop an innovative and responsive program to capture and enhance the developing agricultural opportunities of Montana and Pacific Northwest/Northern High Plains regions.

BPI funds research projects that strive to increase the profitability of Montana agriculture, enhance the health of the human population, and reduce our reliance on non-renewable energy. A prime emphasis of our research is to add value to existing Montana products and to commercialize new products, while maximizing our limited resources and reducing reliance on commodity agriculture. BPI currently supports 26 biobased research projects and has developed several high-value biobased products.

**Input:** Partnerships have been created among producers, the agricultural industry, MSU faculty, and other educational institutions in the region. These partnerships provide outreach activities related to biobased products and food science that are disseminated widely across the region. BPI uses input from focus groups and meetings of stakeholders to identify strategies for marketing higher value agricultural commodities, consumer products, and alternative crops. MSU research provides the technology and biotechnology that improve plant and animal production systems while adding value and improving food security for our

stakeholders.

Research Activities: BPI funds cutting edge research that is innovative and responsive to the developing needs of the region by: (1) developing value-added end-use products with a competitive edge; (2) enhancing agricultural production through innovative approaches; (3) developing systems for food safety and agricultural security; (4) establishing biobased product and food science education and research; (6) enhancing partnerships across the region; and (7) conducting outreach activities related to biobased products and food science for producer, agribusiness, and others.

BPI has been instrumental in identifying potential oilseed crops suitable for production in Montana for use as culinary oils, biolubricants, omega-3 oils, feeds, and production of biodiesel and bioenergy products. Several products are being produced and marketed by private industry or grower cooperatives including PrOatina gluten-free oats to the celiac community and beta-glucan to the nutraceutical industry. Fenugreek, an annual legume, shows promise as a nutraceutical feed for geriatric and athletic horses. Teff is being developed as gluten-free flour for production in eastern Montana. Research continues into developing alternative crops in Montana. Canola, chickpea, fenugreek, camelina, and assorted herbs have been evaluated for their potential in emerging value-added markets. Oilseeds (including Camelina sativa, canola, soybean, and safflower) are rapidly emerging as important Montana crops for production of culinary oils, biolubricants, omega-3 oils, feeds, and biodiesel. Technology transfer collaborative relationships have been developed with the Montana Ag Innovation Center, MSU TechRanch, and MSU TechLink. Collaborators have expertise in incubating new products and businesses and assisting existing businesses.

Additional initiatives will provide new insights into food safety and risk assessment issues, the use of vegetable oils as feedstock for fuel cells, the development of new wheat varieties, non-corrosive biobased de-icers, and the optimization of ethanol production from various feedstocks. Montana's wheat products are important in Asian markets where grain hardness and cereal quality are important considerations. Continued genetic research into the expression of undesirable characteristics in grains will help ensure that the grains will maintain their commanding presence in the market. The use of transgenic crops presents questions regarding the potential risk to human health and the environment. Computer modeling and data from greenhouse and field experiments will help in risk assessments to estimate what hazards may be associated with transgenic crops.

#### Integrated Pest Management (IPM)

Situation: Integrated Pest Management (IPM) is an effective, common-sense, and environmentally sensitive approach to pest management that uses pest control methods (including cultural, biological, genetic, and chemical) to prevent unacceptable levels of pest damage using the most economical means, and with the least possible hazard to people, property, and the environment. In Montana, this approach can be used in both agricultural and non-agricultural settings, such as the home, garden, and workplace. Weeds, diseases, and insects continually challenge Montana producers who are often producing crops under less than ideal conditions. Difficult-to-control pests challenge producers and researchers to evaluate new IPM control methodologies in order to maintain a competitive position in U.S. and world markets. The increase in public concern about food quality, natural resource biodiversity, and sustainability of the quality of soil, air, and water is mandating less reliance on traditional pesticides and research into more environmentally friendly systems, including biological controls. Foreign trade partners want decreased pesticide residues in the wheat and barley commodities being imported into their countries.

Priorities: IPM programs in Montana seek to optimize grower profitability and natural resource sustainability through the development, selection, and implementation of economically sound and environmentally acceptable pest management strategies. Addressing the stakeholder's concern about pest control measures affecting food safety and food quality, MSU is continuing research into less chemically dependent systems. Crop rotation systems, crop production methods, and water management issues all are priorities in the production of abundant high quality crops. Unraveling complex ecological relationships is central to understanding pest management systems, implementing biological controls, and exploring a multitude of science-based options is a part of those systems. Research continues to address both the economic feasibility and environmental impact of biological control.

Inputs: The source of funds contributing to the research conducted by MAES faculty include, but are not limited to: Montana crop and animal agricultural groups, other states, private donations, private industry, Montana Ag Business Association, Montana Department of Agriculture, Montana Fertilizer Advisory Committee, Montana Grain Elevator Association, Montana Noxious Weed Trust Fund, Montana Wheat and Barley Committee, Western Sustainable Agricultural Program, and USDA. Stakeholder input is collected in county- and reservation agent-sponsored input meetings, listening sessions during pesticide applicator education programs, and a Farm Bill Forum. The development of more environmentally friendly chemical and non-chemical alternatives requires ongoing interaction with chemical and biological pest control product manufacturers, state and federal agencies, and with researchers in other states.

Research Activities: Montana's stakeholders need new and improved methods for controlling insects, weeds, and diseases. Comprehensive programs have been established at MSU to investigate control options and promote sustainable practices will help stakeholders be more productive.

Insects affect grain, alfalfa, and row crop producers, rangeland managers, and urban dwellers. The production of adequate and quality hay is critical to the success of livestock producers in Montana. Determining factors that impact beneficial insects, and finding options to reduce yield damaging insects are priorities for this crop. The development of reduced impact alternatives, including biological controls, for the key pests of forage is being investigated. Alfalfa management programs have been initiated to look at traditional use of chemical control methods, non-chemical control methods, and cultural management options.

Incorporating biopesticides into insect management plans can conserve natural enemies and pollinators. Managing forage insects while protecting beneficial insects, especially honeybees, is a difficult challenge. Montana beekeepers accounted for 5.9 percent of the nation's honey in 2004, placing Montana fifth among states in honey production. Research into forages includes the examination of pest and natural enemy complexes and their interaction. Our work over the past several years has provided important groundwork for this research including the development of a large reference collection of bee and wasp species from several Montana locations. We have made substantial progress creating pollen reference collections for several of the sites and have documented the local flowering plant flora at sites where we will be conducting diversity and behavioral studies.

The wheat stem sawfly is a severe pest of wheat in the northern Great Plains, with current management based primarily on the adoption of solid-stem varieties that offer partial resistance to the pest. The most dramatic impact of the wheat stem sawfly is the lodging of damaged stems and harvest losses. Projects at MSU seek to examine the integration of natural enemies, pathogens, and chemicals for management of this pest. New sources of host plant resistance are also being developed as tools for more sustainable management of the pest.

About 90% of the major diseases of the principle crops in the United States are caused by soilborne plant pathogens and result in revenue losses in excess of \$4 billion/year. Soil-borne plant pathogens reduce crop productivity, and their control normally requires pesticide applications. MSU projects identify effective and economical biological controls for diseases caused by plant pathogens. The information developed through this research will help growers control plant diseases using relatively nontoxic methods.

The management of diseases in potatoes and sugar beets is becoming increasingly difficult according to growers who participate in MSU sponsored meetings. Continuing work is being done to investigate disease control approaches with two *Bacillus* biological control agents, *Bacillus mycoides* isolate BacJ and MSU 203-7, in field and greenhouse trials. Management of *Fusarium* yellows, *Cercospora* leaf spot, *Rhizoctonia* crown and root rot, and *Aphanomyces* root rot has increased grower profits on more than 88,000 acres in Montana. Additional research into alternative control methods and more widespread adoption of currently successful systems will continue to grow farming profits. A new potato fungicide management program was developed by MAES research and continues to be used for control of *Rhizoctonia* black scurf in potatoes. Continuing research into novel disease management systems for potatoes will further reduce grower's dependence on single management tools for protection of their crop.

Wheat and barley are major crops in Montana representing nearly \$650 million in receipts to Montana growers. Research projects at MSU are investigating control measures and basic biology of such diseases as *Fusarium* crown rot, *Fusarium* root rot, take-all, *Phymatotrichum* root rot, *Verticillium*, *Phytophthora*, *Rhizoctonia* black scurf, canker, and nematode-caused diseases. Some biocontrol agents are now available commercially; however problems with production, storage, delivery, reliability, efficacy, and establishment have prevented most products from reaching commercial sustainability. Research is ongoing to find additional environmentally friendly solutions for management of plant diseases.

With the adoption of one management practice, new challenges can occur. No-till cereal production combined with a conversion from wheat-fallow to annual cropping has lead to more intensive disease pressure for Montana producers. The purpose of one MSU project is to address cereal disease problems that are exacerbated by the adoption of no-till.

In discussions about problem weeds in Montana, stakeholders most often mention spotted knapweed, Canada thistle, and kochia as their most severe problems in rangelands and pasture. Wild oats continue to be the predominant weed for small grains producers. In order to continue to serve the stakeholders with improved recommendations and non-chemical alternatives, several research projects are underway to evaluate innovative control measures.

Spotted knapweed is a biennial or short-lived perennial that commonly grows to three to four feet tall and continues to spread throughout the state. Biological control is an important component in the management of spotted knapweed. One MSU project looks at managing exotic weeds through the introduction of natural enemies; another manages spotted knapweed through the controlled grazing by sheep. For biological controls to be effective, evaluation of their long-term impacts on ecological communities must be made prior to their release. Natural enemy efficacy studies are underway and will observe the ecological and physiological basis for insect-host interactions. The identification and testing of various arthropods for the biological control of hoary-cress, field bindweed, rush skeletonweed, Russian knapweed, tansy ragwort, and invasive hawkweeds continued in 2006 in our quarantine facility at MSU and at multiple Montana locations. The project was established to determine the environmental safety of exotic natural enemy candidates prior to their release into the environment. One MSU project evaluates strategies to enhance the effectiveness of plant pathogens for control of noxious weeds. Improving the understanding of soil resource use by invasive species may allow control efforts to focus on locations or years when soil conditions may favor invasion, or conversely, when plants may be

more vulnerable to management activities.

Herbicide use in Montana's grain production systems represents the single largest use of pesticides in the state. Weed management tools require continual updating due to changes in weed complexes and resistance to herbicides. The molecular processes that underlay the ability of weeds to compete are poorly understood. A project focuses on the comparison of herbicide resistant and non-resistant kochia biotypes. Basic knowledge of the mechanisms of weed resistance helps manufacturers of crop protection products develop herbicides that target specific biochemical processes within the plant. As part of a service to Montana agricultural producers and in close collaboration with industry, MSU continues to conduct herbicide screening trials to assess the effectiveness of new and existing products for weed control in small grains, sugar beets, and potatoes, under a range of environmental and crop conditions representative of Montana agriculture. Millions of dollars are spent annually on wild oat control in the Northern Great Plains. Wild oats are being used as a model weed species to determine if dormancy or other maternal plant or seed characteristics are associated with the ability of non-germinated wild oat seeds to persist in the soil and resist decay. The long-term goal of this research is to improve weed management by developing a basic understanding of factors that influence weed seed bank decline and identifying causes of weed seed mortality.

#### Plant Breeding, Genetics, and Genomics

Situation: MSU is a recognized international leader in the development of new varieties of wheat and barley that are sought by buyers around the globe. Montana is a state with limited crop diversity due to semi-arid conditions, a short growing season, and the potential for long and severe winters. This limited diversity has made the state a prime area for growing small grains, but restricts the options of producers who may want to grow other crops. Researchers continue to evaluate germplasm and identify traits that will produce higher quality wheat and barley to meet increasing world demands for quality and alternative uses, while maintaining yields. An aggressive plant breeding program ensures development of higher yielding, disease- and insect-resistant wheat and barley cultivars. Much of the North Dakota/Minnesota Red River Valley malting barley production is moving to Montana and Idaho, thus increasing the level of research needed to provide suitable varieties for Montana growing conditions that will be approved by the industry. Additional work in the development of alternative crops continues to produce potential new market opportunities for Montana producers.

A major effort is underway to characterize and evaluate wheat and barley germplasm and to increase the utilization of world germplasm collections. Databases have been made available for researchers to access information on germplasm. A recently released solid stem winter wheat cultivar, Genou, has improved yield potential especially in wheat stem sawfly-infested areas of Montana. Through stakeholder input, we are routinely applying for PVP title V status on all released wheat and barley varieties. Many new improved cultivars are licensed with partnering Montana companies, thus ensuring that Montana stakeholders receive maximum benefit from research discoveries. Research results are distributed to farmers, colleagues, and stakeholders through technical and non-technical publications, through the release of germplasm, and through new genomics tools and techniques. Priorities: MSU seeks to maintain its role as a leading university in wheat and barley genetics research. Primary breeding objectives include increased yield potential, improved winterhardiness, wheat stem sawfly resistance, imidazolinone herbicide tolerance, and enhanced dual-purpose end-use quality. Intensive genomic research will help Montana producers stay competitive and will provide improved cultivars adapted to Montana climatic conditions and cropping systems. Increased understanding of the molecular biology and biochemistry of cereal grains will lead to the development of products more suited to the requirements of developing world markets.

Input: Recommendations and priorities are established by foreign trade teams, international trade missions, faculty, staff, and students statewide. Farmers cooperate by providing dryland and irrigated fields for variety trials and by providing associated inputs. Research grants and proposals are received from the Montana Wheat and Barley Committee.

Research Activities: The development and distribution of improved barley varieties that provide the highest possible production are priorities of barley breeding program. Programs use quality field research technologies, extensive on-station and on-farm trials, and state-of-the-art genomics tools to develop well-adapted, high yielding, improved quality barley varieties. Barley research will continue to focus on the development of high quality drought tolerant lines for the malting, feed, and ethanol industries. Varieties with improved feed quality could provide sustainable seed and grain markets for regional grain producers and marketing advantages to regional beef producers. Identifying factors affecting feed quality of barley for beef cattle and genetic mapping information are being used to develop barley varieties with improved feed quality. Project members generate new genetic diversity by making more than one hundred targeted crosses per year between lines carrying genes conferring improved quality traits or stress tolerance and well-adapted, high yielding barley varieties. Our understanding of the genetic control of traits like winter hardiness, feed quality, malting quality, and drought tolerance has been developed and extended through these experiments. Three malting barley lines are now in plant scale test with the malting and brewing industries. Due to their drought tolerance advantages, the lines are likely to result in a near 50% improvement in dryland farmer success and result in \$10 million per year in increased Montana farming revenues.

Montana crop producers want improved hard red and hard white winter wheat cultivars that are adapted to Montana conditions and suitable for both domestic and export markets. The Asian noodle market is an important business opportunity for Montana growers. The quality of noodles made from different wheat samples is evaluated on entries from the advanced and intrastate nurseries. Polyphenol oxidases (PPOs) have been implicated in wheat product quality problems, including the undesirable darkening of Asian noodles. Major progress has been made in the characterization of wheat kernel PPOs. A long-term goal of this research is the development of low-PPO germplasm with higher commercial value. Wheat grain hardness is a primary factor in cereal quality. MSU research examines the degree to which the puroindoline proteins control wheat grain hardness and cereal quality and what alterations can be made to generate desired milling and end-product quality. Further research will address the effects that modifying the starch biosynthetic pathway has upon grain hardness, milling quality, yield, and end-product quality. Successful genetic research will increase the competitiveness of Montana wheat producers through improved winter wheat varieties with enhanced yield potential, pest resistance, and end-use qualities. In addition to improved cultivar characteristics, researchers are evaluating more efficient screening, selection and breeding strategies and procedures to maximize efficiency and genetic progress in breeding programs. Postharvest resistance to insects has not been a breeding program objective, but could be a secondary objective provided that milling, baking, noodle quality, and other important properties are not affected. In addition to development and release of superior cultivars, research is conducted to maximize production and quality consistency of Montana wheat. A new winter solid stem wheat cultivar, Genou, was released to Montana seed growers in the fall of 2004. Based on average planted acreage and prices, development of an improved winter wheat cultivar which produces an additional one bushel per acre either by enhanced yield or reduced yield loss to disease, insects, or environmental stresses, potentially impacts the Montana economy by \$5–\$6 million, annually.

Hard red spring wheat is the leading crop in Montana. Farmers need new and better varieties to remain competitive. Research objectives include the development of new spring wheat varieties for Montana producers and contributing to the science of wheat breeding and genetics. Bread making characteristics, especially dough strength and extensibility, are considered when evaluating spring wheat cultivars. New varieties with excellent qualities will ensure that Montana wheat retains or increases its share of Asian and domestic markets. Future productivity of the breeding program will be addressed by our efforts to improve our understanding of the genetics of key traits, and to develop new selection tools. New cultivars depend on a diverse source of genetic variability. Conserving and evaluating new plant germplasm is an important step in the cultivar development process. The broader impacts of the work are a larger food supply for the world, an improved ability of Montana farmers to compete in a global marketplace, and a strengthening of export markets for U.S. wheat.

Alfalfa is the most important forage legume grown in Montana. Proprietary companies are generally doing a good job developing varieties that perform well under irrigated conditions, but are not working on dryland cultivars. MSU is seeking to develop multiple pest-resistant dryland cultivars with good agronomic traits for Montana. In addition to alfalfa projects, efforts have been made to assist in the development of new grass varieties for Montana. MSU research has resulted in the release of new grass cultivars and a new sainfoin cultivar.

Whitebark pine forests are in serious decline due to blister rust and mountain pine beetles; their decline will likely affect grizzly bear populations that depend on the pine nuts for food. Mycorrhizal fungi are crucial to the sustainability of these forests, yet we know nothing of the fungi associated with this tree species. The objective of this research is to develop systems to inoculate nursery grown stock with appropriate native fungi that will prevent further decline and begin to reestablish forested areas.

Plant viruses are used as protein cage architectures for the synthesis of nanomaterials. Projects are in place to use plant viruses as biotemplates for the fabrication of nanomaterials with applications in agriculture, medicine, and material sciences. The advances made have demonstrated that it is possible to modify plant viruses and other protein cage architectures to impart novel function. These discoveries significantly contribute to Montana's and the nation's effort in nanotechnology.

Plant photoreceptors and the light responses they control are critical to growth and development of crop and non-crop species throughout the world. Developing an understanding of how the phytochrome photoreceptors work is a critical part of the search for new and effective ways to sustain and improve agronomic performance. Identification of the genes involved in control of inflorescence development will provide new approaches to altering the architecture of plants.

#### Sustainable Agriculture

Situation: Sustainability rests on the principle that we must meet the needs of the present without compromising the ability of future generations to meet their own needs. Researching new crops and finding new markets for existing crops are potential ways to enhance Montana's growth in sustainable agriculture. Montana producers have a greater opportunity to produce commodities in a relatively pest-free environment than many other states due to the extreme winters that kill many pests that may overwinter in other areas of the country. Farmers and ranchers in Montana have historically practiced sustainable activities due to the marginal opportunities for success in a semi-arid climate. A basic principle of sustainable agriculture is to investigate current agricultural practices and find economically feasible and environmentally friendly alternatives to current agricultural practices. These include

optimizing the use of chemicals for pest control, using alternative tillage systems, and increasing crop diversity. With the continuing rise in fuel prices, farming practices that reduce dependence on fuel will add to the profitability of the enterprise. This factor alone provides incentives to farmers to investigate sustainable agricultural methods.

Priorities: To decrease Montana’s primary dependence on small grains and forage crops, research is being conducted on the feasibility of growing a variety of crops including pulse crops (pea, lentil, chickpea, and soybean), herbs, mustard, safflower, sunflower, canola, turf and specialty grains. We are presently researching alternative pest control practices, including biological pest control for forages, potatoes, small grains and sugar beets, which are of utmost interest to stakeholders. Our priority to develop competitive, sustainable, and viable plant and animal systems for Montana stakeholders are reflected in the research conducted in sustainable agricultural projects.

Input: Evaluation surveys of recent farm conferences in Montana highlight strong producer interest in diversified crop rotations. Information and financial assistance comes from alternative energy groups, conservation tillage equipment companies, crop protection companies, fertilizer advisory committees, Montana Wheat and Barley Committee, Organic Certification Association of Montana, and state agricultural advisory committees.

The effects of MSU research in sustainable agriculture have an immediate impact on crop and livestock enterprises. The shift to more efficient and profitable specialty crops will continue to generate major interest in the future. The use of the Internet for information dissemination has become an increasingly valuable method to provide stakeholders with materials to assist in their decision-making. While meetings, interviews, and focus groups will continue to be used to gather information from stakeholders, the increasing use of computer modeling and surveys will add to data being collected. As technology advances and producers begin to rely more on computer-aided information, the role of MSU research and outreach will continue to increase in their importance and impact.

Research Activities: In Montana and throughout the U.S., maintaining profitable agricultural enterprises while sustaining ecological systems has become a difficult balancing act that often results in changes in agricultural practices and environmental policy. Analyses of historical photographs confirm that conifers have encroached upon large acreages of Montana rangeland, reducing forage production, decreasing the flow of water from springs and creeks, and degrading fish habitat and riparian ecosystems. Prescribed livestock browsing is a promising tool to better enable range and livestock managers to suppress conifers. Livestock grazing practices are receiving increasing attention because of their perceived negative impacts on soils, biodiversity, and water quality. Point sources of water pollution are often associated with livestock confined to certain areas while being fed hay during winter. Cattle may graze foothill rangelands in northern latitudes as an alternative to feeding hay. Understanding the requirements of cattle during winter months will help producers plan feeding schedules and adjust protection requirements from severe weather conditions.

Most land managers agree that the spread of non-native invasive plants

**Estimated Number of Professional FTEs/SYs total in the State.**

Year	Extension		Research	
	1862	1890	1862	1890
2008	6.0	0.0	44.8	0.0
2009	6.0	0.0	44.8	0.0
2010	6.0	0.0	44.8	0.0
2011	6.0	0.0	44.8	0.0
2012	6.0	0.0	44.8	0.0

**II. Merit Review Process**

**1. The Merit Review Process that will be Employed during the 5-Year POW Cycle**

- Internal University Panel
- External Non-University Panel
- Other (Dept. Head External to PI's Dept. )

## 2. Brief Explanation

Hatch Projects are subject to a rigorous review at the department level, followed by a peer review, with final approval at the Director's level. The MAES Director's Office has oversight of this review process. The peer review committee, selected by the Director after consultation with College of Agriculture department heads, includes the principle investigator's (PI) department head, MAES administrator, one department peer reviewer and two additional faculty external to the PI's department. Seminars are presented to the review committee and to interested stakeholders, including faculty, staff, students, and constituents. New projects are required to be proposed for a 3-year period, while ongoing projects that receive a favorable merit review can be written for a 5-year period. No Agricultural Experiment Station funds are allocated outside of the College of Agriculture, consequently external expert review occurs with Montana State University-Bozeman faculty external to the College of Agriculture, as a requirement of the review process. The seminars are announced on the web, ensuring broader attendance and input potential. Reviewers are requested to provide written recommendations on the following items: relevance and importance of the project; relation of the project to previous research; objectives; approach and methods; scientific and technical quality; resources; environmental, economic, and/or social impacts. The responses are presented to the PI during a subsequent meeting with the MAES administrator and department head. Projects that do not meet expectations will not be approved and action upon them will be deferred until all of the key elements listed above have been met. Ultimately, Director-approved projects are submitted to USDA CSREES for final approval.

## III. Evaluation of Multis & Joint Activities

### 1. How will the planned programs address the critical issues of strategic importance, including those identified by the stakeholders?

Planned research programs adhere to regional and Montana protocols and priorities through continual review at regional and State levels. The Western Region of Experiment Station Directors reviews productivity through careful committee analysis of annual results tied back to the regional objectives. Direct ongoing participation of faculty, staff, and students on the projects in Montana feed into multi-state projects and selected objectives. In addition, on a biennial basis the MAES is reviewed and funded by the State. In non-legislative years, the Legislative Fiscal Analysis Division reviews goals and performance measures for compliance.

### 2. How will the planned programs address the needs of under-served and under-represented populations of the State(s)?

Montana has a very small overall population and an even smaller percentage of under-served and under-represented populations. Where applicable and where there is good opportunity for success, we are actively engaging in collaborative research and education that would address Native American issues. We are working closely with Reservation County Agents to identify key problems that, if they align with our expertise and resources, will result in research that addresses key issues and problems. The MAES is also working with the USDA ARS on collaborative projects at facilities and associated regions in Sidney and Miles City, Montana. In addition, Bozeman-based faculty members periodically teach at the 1994 Institutions for short periods of time, typically in the summer.

### 3. How will the planned programs describe the expected outcomes and impacts?

In order to continue receiving State support that is five times the amount of federal support (Hatch, Multistate and Animal Health), our research must demonstrate actual or potential economic impact to Montana's economy and solve problems at the local-to-state level. In simple terms, this could be the result of increased crop yields or through advances in crop or animal production efficiency. Deriving additional income from value-added products and new enterprises helps to diversify risk and create additional opportunities for income. As a result of the new knowledge created through research activities, there potentially can be policy changes that impact agency management decisions. For example, the alternative use of coal bed methane waters for irrigating salt and/or sodium tolerant crops can lead to the development of energy resources in an environmentally sound and economically feasible manner. This could lead to new policies on drilling for methane and use of extracted waters. Many of the coal bed methane sites are located on reservations; working with tribal leaders helps to identify their needs in those locations. In addition, if a new vaccine is developed for management of brucellosis in bison, the National Park Service would have new options that could lead to more socially acceptable management of bison in Yellowstone National Park.

#### 4. How will the planned programs result in improved program effectiveness and/or efficiency?

The process of problem identification includes meeting with agricultural and natural resource organizations, securing funding for research operations, and reporting to state and federal officials. This process assists in modifications that lead to improved program effectiveness in delivering research results that, in many cases, enhance agricultural efficiency through new or alternative practices. Research programs take the inherent initial risk, and stakeholders ultimately weigh in on program effectiveness through adoption of new technologies and approaches that provide additional income, reduce risk and sustain the enterprise. In addition, Montana stakeholders provide the impetus for continued and growing financial support through MAES programmatic emphasis important to the number one basic industry, agriculture.

### IV. Stakeholder Input

#### 1. Actions taken to seek stakeholder input that encourages their participation

- Other (Educational outreach programs)
- Targeted invitation to traditional stakeholder individuals
- Targeted invitation to non-traditional stakeholder groups
- Targeted invitation to non-traditional stakeholder individuals
- Targeted invitation to traditional stakeholder groups
- Use of media to announce public meetings and listening sessions

##### Brief explanation.

The Montana Agricultural Experiment Station (MAES) and College of Agriculture (COA) obtain stakeholder input on research priorities and programs. New stakeholder committees have been formed that include the College Development Board, Precision Ag Research Association (PARA), sustainable agriculture focus group, MAES Advisory Council, Ag Coalition and other state and local groups. PARA is external to MAES, charges its own dues, and conducts quarterly meetings throughout Montana with members and selected professionals. MAES scientists routinely participate with this group and NRCS to provide training and expertise in GPS, GIS and remote sensing with geospatial applications. PARA and MSU have secured a number of USDA, NASA, and industry grants to initiate collaborative projects on their property as part of the MSU originated "Learning Groups" concept. The Ag Coalition consists of representation from the Agricultural Business Association, Beef Council, conservation groups, Department of Agriculture, Farm Bureau Federation, Montana Stockgrowers, Montana Farmers Union, Montana Water Users, Montana Wool Growers, and the Seed Trade. It meets every six months with the Dean and Director to review program priorities, new initiatives, fundraising efforts, and legislative activities.

Stakeholder input is collected in county and reservation sponsored input meetings, listening sessions, and a Farm Bill forum. MAES responds to stakeholder inputs by considering their proposals at research planning meetings with scientists, advisory groups, agencies, and administrators. Stakeholder input has been solicited in the strategic planning process and continues throughout as programs are developed, implemented, and changed as dollars are allocated and reallocated. Survey have been used to collect input from representative groups of stakeholders in Montana. Questions in the survey were based upon the areas of emphasis in the strategic plans of the COA/MAES and the Extension Service.

#### 2(A). A brief statement of the process that will be used by the recipient institution to identify individuals and groups stakeholders and to collect input from them

##### 1. Method to identify individuals and groups

- Open Listening Sessions
- Use Advisory Committees
- Other (Volunteers, membership on ag. assoc. boards)

##### Brief explanation.

Each of the seven agricultural research centers has an advisory group that meets 2–3 times per year. In addition, a State Advisory Committee meets three times per year to discuss program focus and direction, legislative priorities and productivity/impact. All of these meetings are open to the public. Administrators and faculty in the COA serve on agricultural association committees that

direct and fund research activities that have multiple meetings and communications throughout the year.

**2(B). A brief statement of the process that will be used by the recipient institution to identify individuals and groups who are stakeholders and to collect input from them**

**1. Methods for collecting Stakeholder Input**

- Meeting with the general public (open meeting advertised to all)
- Meeting with traditional Stakeholder individuals
- Survey specifically with non-traditional groups
- Meeting with traditional Stakeholder groups

**Brief explanation**

Through our direct participation with agricultural stakeholder groups, broad participation in committees, and directed meetings, the MAES engages in listening to and considering a defined problem or question that can be addressed through our research programs. The Director targets selective meetings with non-traditional groups. Montana has an open meeting law, so all meetings are open to the public and must have a published agenda.

**3. A statement of how the input will be considered**

- To Identify Emerging Issues
- In the Budget Process
- Redirect Research Programs
- In the Staff Hiring Process
- To Set Priorities

**Brief explanation.**

As a Land Grant Institution, Montana State University has a solid foundation of past and future program activities that allow stakeholder input and strong interactive dialogue. The COA and MAES are the leaders in this regard. We are the primary conduit in connection and delivery of education and new knowledge in agricultural activities throughout rural Montana.

**V. Planned Program Table of Content**

<b>S. NO.</b>	<b>PROGRAM NAME</b>
1	Agronomic and Forage Crops
2	Animal Health
3	Biobased Products and Processing
4	Integrated Pest Management
5	Plant Breeding, Genetics and Genomics
6	Sustainable Agriculture
7	Water Quality and Use

**V(A). Planned Program (Summary)****1. Name of the Planned Program**

Agronomic and Forage Crops

**2. Brief summary about Planned Program**

Research programs in the COA range from basic research in genetics and biotechnology to practical applications in rangeland, forest, crop, and livestock management. Our long-term strategies are designed to make Montana agricultural products more desirable in U.S. and world markets. Summaries of survey information from the Montana Weed Coordinators have identified critical local research needs on the management of invasive plants on private, public and agency lands. This has led to new state funding initiatives and research and education alignment with the Montana Weed Management Plan. Projects in agronomic and forage research at MSU often contain objectives that interconnect with objectives in plant and animal genomics, and biobased and sustainable agriculture. Developing projects that meet more than one objective provides increased value to our stakeholders. Projects in the Agronomic and Forage Crops program area serve to provide new cropping opportunities, increased markets, and substantial economic benefit for Montana growers.

Research Activities: Surveys at Montana farm conferences indicated a strong interest in diversified crop rotations. Crop diversity studies continue to show promise for increasing on-farm receipts while reducing dependency on small grains. Diversifying dryland cropping systems that include oilseed and pulse crops in sequence with cereal crops is a viable and sustainable approach to crop production. The use of reduced tillage and no-till systems are being evaluated to demonstrate their sustainability. Winter and spring peas, canola, corn, lentil, mustard, sunflower, triticale, and chickpea are included in long-term rotation studies. Research into new crops such as dwarf and slow-growing lawn grasses, native ornamental flowers, essential oils, and crops for natural rubber production and bio-energy are examples of research that will provide opportunities for growers and their communities. Research is being conducted on elk and cattle habitat use patterns in Montana and Wyoming. An evaluation of livestock distribution practices on grazed watersheds is part of a three-state project (MT, CA, OR) and shows the potential to manipulate cattle grazing patterns to protect and improve fishery and wildlife habitat. Grazing and fire recovery in rangelands are priority issues to be studied in Montana and Wyoming, especially in light of the large forest fires that occurred in Montana in 2006. Grazing projects serve the need to provide economic and environmentally sensitive programs for Montana stakeholders. Studies in precision agriculture have led to the development of a tool for a rapid nondestructive characterization of soils for a variety of environmental and agricultural applications. This invention could dramatically increase the availability of soil data for monitoring carbon sequestration in agricultural lands, since monitoring carbon data has become a priority project for understanding agriculture's role in the production of greenhouse gases.

**3. Program existence :** Intermediate (One to five years)

**4. Program duration :** Long-Term (More than five years)

**5. Expending formula funds or state-matching funds :** Yes

**6. Expending other than formula funds or state-matching funds :** Yes

**V(B). Program Knowledge Area(s)****1. Program Knowledge Areas and Percentage**

- 101 10% Appraisal of Soil Resources
- 112 10% Watershed Protection and Management
- 121 30% Management of Range Resources
- 203 10% Plant Biological Efficiency and Abiotic Stresses Affecting Plants
- 204 10% Plant Product Quality and Utility (Preharvest)
- 205 30% Plant Management Systems

**V(C). Planned Program (Situation and Scope)****1. Situation and priorities**

Montana has limited crop and livestock diversity due to its semi-arid environment, a short growing season, and the potential for long and severe winters. Cattle and sheep are the primary livestock enterprises; small grains, forages and short season specialty crop make up the bulk of the cropping activity. With limited diversity, researchers at MSU are able to delve deeper into understanding each entity from production and management studies as well as through plant and animal genomics. Agricultural cash receipts in Montana total over \$3.0 billion annually and are made up of roughly a 55:45 mix of livestock and crops

respectively. In addition, Montana is world-renowned for the quality of its wheat and beef cattle.

Priorities established in this program include to:

Characterize and understand the complex interactive components of habitats that will lead to improved soil, plant and water resources

Create better grazing management in concert with the preservation of riparian habitats, wildlife and clean water

Demonstrate innovation in recommended approaches to crop and pest management

Develop greater nutritional value for forages

Develop higher disease and insect resistance in wheat and barley

Develop higher yielding varieties

Establish new value-added crops

Establish research programs that provide more efficient use of natural resources, especially water

**2. Scope of the Program**

- Multistate Research
- In-State Extension
- In-State Research

**V(D). Planned Program (Assumptions and Goals)**

**1. Assumptions made for the Program**

Adequate moisture (rainfall, irrigation, snowpack) will be available for crops to be produced

Corporate funding organizations, grain and livestock associations, chemical companies, and other agencies will continue to provide input into priorities and activities

Fulltime staff and part time assistants will be available to maintain appropriate progress on the project

Funding and technical support will be maintained from partnering institutions and cooperators

Program development will proceed as planned without major interruptions

**2. Ultimate goal(s) of this Program**

Create better grazing management recommendations to cattle producers

Develop higher disease and insect resistance in wheat and barley and greater nutritional value for forages

Develop higher yielding varieties and introduce new value-added crops

Provide crop management options and establish research programs that are consistent with environmental and sustainable agricultural objectives

**V(E). Planned Program (Inputs)**

**1. Estimated Number of professional FTE/SYs to be budgeted for this Program**

Year	Extension		Research	
	1862	1890	1862	1890
2008	1.0	0.0	4.4	0.0
2009	1.0	0.0	4.4	0.0
2010	1.0	0.0	4.4	0.0
2011	1.0	0.0	4.4	0.0
2012	1.0	0.0	4.4	0.0

**V(F). Planned Program (Activity)**

**1. Activity for the Program**

Development of research summaries and fact sheets

Training in cooperation with the Montana Hay Growers Association, Montana Alfalfa Seed Growers Association and Montana Grain Growers Association

Workshops and meetings with federal and state land management agencies

**2. Type(s) of methods to be used to reach direct and indirect contacts**

Extension	
Direct Methods	Indirect Methods
<ul style="list-style-type: none"> <li>● Demonstrations</li> <li>● Workshop</li> </ul>	<ul style="list-style-type: none"> <li>● Newsletters</li> </ul>

**3. Description of targeted audience**

Crop and livestock producers in Montana

State agricultural advisory committees

State of Montana, Montana Department of Agriculture, Bureau of Land Management, USFS, and other government entities

Participants in extension and commodity group meetings, conferences and field days

**V(G). Planned Program (Outputs)**

**1. Standard output measures**

**Target for the number of persons(contacts) to be reached through direct and indirect contact methods**

	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Year	Target	Target	Target	Target
2008	125	200	0	0
2009	150	200	0	0
2010	175	200	0	0
2011	200	200	0	0
2012	225	200	0	0

**2. (Standard Research Target) Number of Patents**

**Expected Patents**

2008 :0

2009 :1

2010 :0

2011 :1

2012 :0

**3. Expected Peer Review Publications**

Year	Research Target	Extension Target
2008	5	5
2009	5	5
2010	5	5
2011	5	5
2012	5	5

**V(H). State Defined Outputs**

**1. Output Target**

- Number of research citations

2008 :8                      2009 :10                      2010 : 12                      2011 :14                      2012 :16

**V(I). State Defined Outcome**

**1. Outcome Target**

Number of new crops evaluated per year for adaptation potential in Montana

**2. Outcome Type :** Change in Knowledge Outcome Measure

2008 :2                      2009 : 2                      2010 : 2                      2011 :2                      2012 : 0

**3. Associated Knowledge Area(s)**

- 203 - Plant Biological Efficiency and Abiotic Stresses Affecting Plants
- 204 - Plant Product Quality and Utility (Preharvest)
- 205 - Plant Management Systems

**1. Outcome Target**

Number of new crops and varieties adopted per year

**2. Outcome Type :** Change in Action Outcome Measure

2008 :1                      2009 : 1                      2010 : 1                      2011 :1                      2012 : 1

**3. Associated Knowledge Area(s)**

- 203 - Plant Biological Efficiency and Abiotic Stresses Affecting Plants
- 204 - Plant Product Quality and Utility (Preharvest)
- 205 - Plant Management Systems

**1. Outcome Target**

Increase in acres of non-traditional crops planted in Montana

**2. Outcome Type :** Change in Condition Outcome Measure

2008 :5000                      2009 : 5000                      2010 : 5000                      2011 :5000                      2012 : 5000

**3. Associated Knowledge Area(s)**

- 205 - Plant Management Systems

**1. Outcome Target**

Number of routine field crop and forage samples processed by the MSU Seed Laboratory per year

**2. Outcome Type :** Change in Action Outcome Measure

2008 :750                      2009 : 750                      2010 : 750                      2011 :750                      2012 : 750

**3. Associated Knowledge Area(s)**

- 121 - Management of Range Resources
- 205 - Plant Management Systems

**1. Outcome Target**

New grazing plans established for livestock and wildlife in rangeland environments

**2. Outcome Type :** Change in Condition Outcome Measure

**2008 :**10

**2009 :** 10

**2010 :** 10

**2011 :**10

**2012 :** 10

**3. Associated Knowledge Area(s)**

- 121 - Management of Range Resources

**V(J). Planned Program (External Factors)**

**1. External Factors which may affect Outcomes**

- Natural Disasters (drought,weather extremes,etc.)
- Appropriations changes
- Government Regulations
- Public Policy changes

**Description**

Inadequate funding and technical support from partnering institutions and cooperators

Inadequate moisture (rainfall, irrigation, snowpack) for crops to be produced and creating too much variability

Lack of fulltime staff and part time assistants for the projects

Major interruptions in program development

Reduced support from Montana crop and animal agricultural groups, conservation and wildlife groups, private industry, private donations, and other agencies

**V(K). Planned Program (Evaluation Studies and Data Collection)**

**1. Evaluation Studies Planned**

- During (during program)
- After Only (post program)

**Description**

Evaluation studies will be conducted annually through the issuance of surveys, published peer review materials, and secured peer reviewed grant proposals.

**2. Data Collection Methods**

- Mail

**Description**

Data collection will be obtained through surveys at meetings, conventions, advisory boards, and by direct contact

**V(A). Planned Program (Summary)****1. Name of the Planned Program**

Animal Health

**2. Brief summary about Planned Program**

Maintaining high quality meat, milk, and fiber products from Montana livestock is a major focus. Losses due to environmental stresses, diseases, and mortality create the need for an improved understanding of the factors affecting Montana livestock. Disease control and the improvement of livestock performance affect all livestock producers in their ability to raise healthy stock and reduce economic losses. Producing high quality animals and obtaining the highest profit potential are essential for Montana to maintain or exceed its current ranks in the national cattle and sheep industry. Promoting and maintaining animal health (cattle, sheep, horses, and wildlife) has led to advances in genetics and reproductive science and improved animal performance. By understanding immune systems and parasite development in livestock and by developing novel genes and new biochemical routes of activity for vaccines, important diseases may be managed more effectively.

Research Activities: Specific projects have been established to investigate diseases and animal productivity in cattle, sheep, and bison. Any advances that can be made in improving cattle and sheep output economically benefits all Montana livestock producers. Bison research focuses on the development of efficacious brucellosis vaccines. A better understanding of the mechanisms involved in the spread of brucellosis directly addresses concerns of cattle producers in areas near Yellowstone National Park (YNP) and could aid in the management of bison by YNP wildlife managers. Cattle research focuses on disease control, reproductive enhancement, and animal productivity. Programs are in place to investigate vaccines for rotavirus, prion diseases, coccidiosis, herpesviruses, and mastitis in cattle. Research continues into winter maintenance programs for cattle and sheep to improve performance and reduce stress caused by diseases and losses. Equine strangles continues to be a problem to horse health and industry, despite the widespread use of commercial vaccines. Researchers are investigating the roles of antigenic cell surface proteins of *S. equi* in their contribution to disease in horses. Studies are being conducted to determine the potential for the development of vaccines for West Nile and bluetongue viruses. Research is being established to understand the cause and development of and immunity to bovine shipping fever and to develop novel strategies for the prevention and control of this disease complex.

**3. Program existence :** New (One year or less)

**4. Program duration :** Long-Term (More than five years)

**5. Expending formula funds or state-matching funds :** Yes

**6. Expending other than formula funds or state-matching funds :** Yes

**V(B). Program Knowledge Area(s)****1. Program Knowledge Areas and Percentage**

- 121 10% Management of Range Resources
- 301 10% Reproductive Performance of Animals
- 302 10% Nutrient Utilization in Animals
- 303 10% Genetic Improvement of Animals
- 311 50% Animal Diseases
- 315 5% Animal Welfare/Well-Being and Protection
- 902 5% Administration of Projects and Programs

**V(C). Planned Program (Situation and Scope)****1. Situation and priorities**

Losses due to environmental stresses, diseases, and mortality create the need for an improved understanding of the factors affecting Montana livestock. Promoting and maintaining animal health (cattle, sheep, and wildlife) has led to advances in genetics, performance, and reproduction technology. In addressing the needs of our stakeholders in Montana and those who rely on MSU's recommendations for animal production in the state, the following priorities have been established:

Demonstrate ways to manage stress in animals during the winter, lower production costs, and improve beef genetics  
Develop and implement new management protocols and/or pharmaceutical and nutritional regimens that will increase the fertility of domestic ruminants

Develop vaccines for Montana livestock that protect them against debilitating diseases  
 Determine how factors, such as herd size and supplement intake, influence growth and development of cattle grazing native rangelands  
 Evaluate barley cultivars in feeding studies to demonstrate their effect on improving feed efficiency and reducing feed costs  
 Improve milk and beef production by targeting mutagenesis of cells in cattle bovine immune cells  
 Test new natural oil additives for improving lamb meat characteristics to increase the competitiveness of U.S. lamb in the world market

**2. Scope of the Program**

- Integrated Research and Extension
- Multistate Extension
- In-State Extension

**V(D). Planned Program (Assumptions and Goals)**

**1. Assumptions made for the Program**

Funding through industry organizations, livestock associations, chemical companies, and other agencies will continue to provide input into priorities and activities  
 Fulltime staff and part time assistants will be available to maintain appropriate progress on the project  
 Funding and technical support will be maintained from partnering institutions and cooperators  
 Program development will proceed as planned without major interruptions

**2. Ultimate goal(s) of this Program**

Increase discovery of novel vaccines for prevention of livestock diseases  
 Maintain our role as a leading university in animal genetics and rangeland stewardship research  
 Provide genomic research that will help Montana producers stay competitive  
 Provide improved production management recommendations to Montana producers

**V(E). Planned Program (Inputs)**

**1. Estimated Number of professional FTE/SYs to be budgeted for this Program**

Year	Extension		Research	
	1862	1890	1862	1890
2008	0.5	0.0	9.3	0.0
2009	0.5	0.0	9.3	0.0
2010	0.5	0.0	9.3	0.0
2011	0.5	0.0	9.3	0.0
2012	0.5	0.0	9.3	0.0

**V(F). Planned Program (Activity)**

**1. Activity for the Program**

Databases that are easily accessible by researchers and producers to make research results more readily available  
 Papers and research results at state nutrition conferences, field days, county meetings and state conventions  
 Research articles, fact sheets and news releases for scientists and state media  
 Strategic planning meetings with state agricultural groups, including the Montana Stockgrowers Association and the Montana Board of Livestock

**2. Type(s) of methods to be used to reach direct and indirect contacts**

Extension	
Direct Methods	Indirect Methods
<ul style="list-style-type: none"> <li>● Education Class</li> <li>● Workshop</li> </ul>	<ul style="list-style-type: none"> <li>● Newsletters</li> </ul>

**3. Description of targeted audience**

Montana Department of Agriculture, animal health companies, and state commodity groups  
 Montana Stockgrowers Association and the Montana Board of Livestock  
 Ranchers, seedstock industry, colleagues and related stakeholders

**V(G). Planned Program (Outputs)**

**1. Standard output measures**

**Target for the number of persons(contacts) to be reached through direct and indirect contact methods**

	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Year	Target	Target	Target	Target
2008	250	100	0	0
2009	250	100	0	0
2010	250	100	0	0
2011	250	100	0	0
2012	250	100	0	0

**2. (Standard Research Target) Number of Patents**

**Expected Patents**

2008 :0                      2009 :1                      2010 :0                      2011 :1                      2012 :0

**3. Expected Peer Review Publications**

Year	Research Target	Extension Target
2008	5	0
2009	5	0
2010	5	0
2011	5	0
2012	5	0

**V(H). State Defined Outputs**

**1. Output Target**

- Number of research citations

2008 :15                      2009 :15                      2010 : 15                      2011 :15                      2012 :15

- Building built through donations

2008 :0                      2009 :0                      2010 : 1                      2011 :0                      2012 :0

**V(I). State Defined Outcome**

**1. Outcome Target**

Identify critical infection and resistance processes

**2. Outcome Type :** Change in Knowledge Outcome Measure

2008 :1                      2009 : 1                      2010 : 1                      2011 :1                      2012 : 1

**3. Associated Knowledge Area(s)**

- 311 - Animal Diseases

**1. Outcome Target**

Number of ranches per year adopting enterprise management of animal health issues

**2. Outcome Type :** Change in Action Outcome Measure

2008 :10                      2009 : 10                      2010 : 10                      2011 :10                      2012 : 10

**3. Associated Knowledge Area(s)**

- 311 - Animal Diseases

**1. Outcome Target**

Number of novel vaccines developed per year

**2. Outcome Type :** Change in Condition Outcome Measure

2008 :0                      2009 : 1                      2010 : 0                      2011 :1                      2012 : 0

**3. Associated Knowledge Area(s)**

- 311 - Animal Diseases
- 315 - Animal Welfare/Well-Being and Protection

**1. Outcome Target**

Number of activities per year that prevent disease outbreaks or manage diseases of Montana livestock

**2. Outcome Type :** Change in Action Outcome Measure

2008 :1                      2009 : 1                      2010 : 1                      2011 :1                      2012 : 1

**3. Associated Knowledge Area(s)**

- 311 - Animal Diseases

**1. Outcome Target**

Number of publications or meetings that maintain or enhance Montana's presence in the production of quality meat products

**2. Outcome Type :** Change in Condition Outcome Measure

2008 :1                      2009 : 1                      2010 : 1                      2011 :1                      2012 : 1

**3. Associated Knowledge Area(s)**

- 303 - Genetic Improvement of Animals

- 902 - Administration of Projects and Programs

## **V(J). Planned Program (External Factors)**

### **1. External Factors which may affect Outcomes**

- Appropriations changes
- Public Policy changes
- Natural Disasters (drought, weather extremes, etc.)
- Government Regulations

#### **Description**

Inadequate funding and technical support from partnering institutions and cooperators

Inadequate moisture (rainfall, irrigation, snowpack) for crops to be produced creating too much variability

Lack of fulltime staff and part time assistants for the projects

Major interruptions in program development

Reduced support from Montana crop and animal agricultural groups, conservation and wildlife groups, private industry, private donations, and other agencies

## **V(K). Planned Program (Evaluation Studies and Data Collection)**

### **1. Evaluation Studies Planned**

- During (during program)
- Retrospective (post program)
- Other (Review with state agencies)

#### **Description**

Evaluation studies will be conducted annually through the issuance of surveys, published peer review materials and secured peer reviewed grant proposals.

### **2. Data Collection Methods**

- Sampling
- Journals
- On-Site

#### **Description**

Data collection will be obtained through surveys at meetings, conventions, advisory boards, and by direct contact.

**V(A). Planned Program (Summary)****1. Name of the Planned Program**

Biobased Products and Processing

**2. Brief summary about Planned Program**

The future of Montana's agricultural economy depends on maximizing net returns per acre or per animal unit with the most efficient use of resources. MSU is a leader in biobased research and development of novel product end uses. A biobased, diversified economy will contribute to the economic development, providing in-state manufacturing, product development, rural development, and jobs. Value added, agriculturally based end products can create unique markets and enhanced revenues for producers. Since Montana exports approximately 85% of its raw commodities, it is increasingly important to capture their inherent economic value by adding value to raw agricultural commodities and processed food products before they leave the State. The development of bioenergy alternatives will also provide opportunities for renewable biobased products and will help to reduce the current dependence on fossil fuels. The revitalization of agriculture and rural communities in Montana is essential for our economic sustainability and competitiveness.

Research Activities: The goal of the Biobased Products Institute (BPI) is to build a biobased economy that provides opportunities and marketing strategies for Montana produced commodities. BPI currently supports 26 biobased research projects and has developed several high value biobased products. Research continues into developing alternative crops in Montana. Canola, chickpea, fenugreek, camelina, and assorted herbs have been evaluated for their potential in emerging value added markets. Oilseeds (including Camelina sativa, canola, soybeans, and safflower) are rapidly emerging as important Montana crops for production of culinary oils, biolubricants, omega-3 oils, feeds, and biodiesel. Over 90 germplasm accessions of camelina have been evaluated for adaptability, yield potential, and fatty acid content. Camelina production could significantly reduce the cost of biodiesel and provide a source for omega-3 oil, which is being evaluated for human consumption. BPI provides funding to support food risk assessment research and education, provides expertise to growers, researchers, and agricultural businesses, and assists in the development and marketing of safe, nutritious, and value added products. The use of transgenic crops presents questions regarding the potential risk to human health and the environment. Computer modeling and data from greenhouse and field experiments will help in risk assessments to estimate what hazards may be associated with transgenic crops.

**3. Program existence :** Intermediate (One to five years)

**4. Program duration :** Long-Term (More than five years)

**5. Expending formula funds or state-matching funds :** Yes

**6. Expending other than formula funds or state-matching funds :** Yes

**V(B). Program Knowledge Area(s)****1. Program Knowledge Areas and Percentage**

- 502 35% New and Improved Food Products
- 511 35% New and Improved Non-Food Products and Processes
- 605 10% Natural Resource and Environmental Economics
- 711 20% Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources.

**V(C). Planned Program (Situation and Scope)****1. Situation and priorities**

The revitalization of agriculture and rural communities in Montana is essential for the state's economic sustainability and competitiveness. A biobased, diversified economy will provide in-state manufacturing, product development, rural development and jobs. The Biobased Products Institute (BPI) through the Board of Directors funds research projects that strives to increase the profitability of Montana agriculture, enhance the health of the human population, and reduce our reliance on non-renewable energy by the production of biofuels, ethanol, and biolubricants. A prime emphasis of our research is to add value to existing Montana products and to commercialize new products, while maximizing limited resources and reducing reliance on commodity agriculture.

The priorities of BPI are to:

Assist in development of safe, nutritious, value added products, risk assessment, and marketing

Develop an innovative and responsive program to enhance the developing needs of the State of Montana and Pacific

Northwest/Northern High Plains regions

Expand development and production of value-added products in Montana  
 Provide expertise to growers, researchers and agricultural businesses  
 Support food risk assessment research and education

**2. Scope of the Program**

- In-State Research
- In-State Extension

**V(D). Planned Program (Assumptions and Goals)**

**1. Assumptions made for the Program**

Adequate moisture (rainfall, irrigation, snowpack) will be available for crops to be produced  
 Funding from industry organizations, grain and livestock associations, chemical companies, and other agencies will continue to provide input into priorities and activities  
 Fulltime staff and part time assistants will be available to maintain appropriate progress  
 Funding and technical support will be maintained from partnering institutions and cooperator  
 Montana businesses and state agencies will be interested in commercialization opportunities  
 Program development will proceed as planned without major interruptions

**2. Ultimate goal(s) of this Program**

Build a biobased economy that provides manufacturing, product development, rural development, job opportunities and an opportunity to raise farm and ranch incomes  
 Develop safe, nutritious, value-added products for U.S. and world consumers  
 Support food risk assessment education and research

**V(E). Planned Program (Inputs)**

**1. Estimated Number of professional FTE/SYs to be budgeted for this Program**

Year	Extension		Research	
	1862	1890	1862	1890
2008	0.5	0.0	13.2	0.0
2009	0.5	0.0	13.2	0.0
2010	0.5	0.0	13.2	0.0
2011	0.5	0.0	13.2	0.0
2012	0.5	0.0	13.2	0.0

**V(F). Planned Program (Activity)**

**1. Activity for the Program**

Several products are being produced and marketed by private industry, LLC, or grower cooperatives in Montana. The Institute has developed additional collaborative relationships with the Montana Ag Innovation Center, MSU TechRanch, and MSU TechLink to facilitate technology transfer from BPI to the private sector. These collaborators have expertise in incubating new businesses and new products, as well as assisting existing enterprises in product expansion.

The Institute will:

- Conduct outreach activities related to biobased products
- Develop systems that ensure food safety and agricultural security
- Develop value-added, agriculturally based end-use products
- Establish biobased product and food science education and research programs
- Enhance partnerships among faculty across the Montana university system, producers, agricultural industry and other educational institutions across the region

Provide mechanisms to enhance agricultural production practices to enhance product quality  
 Use technology and biotechnology to improve plant and animal production systems

**2. Type(s) of methods to be used to reach direct and indirect contacts**

Extension	
Direct Methods	Indirect Methods
<ul style="list-style-type: none"> <li>● Education Class</li> <li>● Group Discussion</li> </ul>	<ul style="list-style-type: none"> <li>● Newsletters</li> </ul>

**3. Description of targeted audience**

Alternative energy groups and state agricultural advisory committees  
 Crop and livestock producers in Montana  
 Economic development groups  
 Participants in extension and commodity group meetings, conventions, and conferences  
 State of Montana, Montana Department of Agriculture, Bureau of Land Management, USFS, and other government entities

**V(G). Planned Program (Outputs)**

**1. Standard output measures**

**Target for the number of persons(contacts) to be reached through direct and indirect contact methods**

	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Year	Target	Target	Target	Target
2008	100	50	0	0
2009	125	50	0	0
2010	150	50	0	0
2011	200	50	0	0
2012	250	50	0	0

**2. (Standard Research Target) Number of Patents**

**Expected Patents**

2008 :1                      2009 :0                      2010 : 1                      2011 : 0                      2012 : 1

**3. Expected Peer Review Publications**

Year	Research Target	Extension Target
2008	5	0
2009	5	0
2010	5	0
2011	5	0
2012	5	0

**V(H). State Defined Outputs**

**1. Output Target**

- New business partnerships created

2008 :2                      2009 :1                      2010 : 1                      2011 :1                      2012 :1

- Number of research citations

2008 :6                      2009 :8                      2010 : 10                      2011 :10                      2012 :12

**V(I). State Defined Outcome**

**1. Outcome Target**

Number of SBIR funding proposals submitted to federal agencies

**2. Outcome Type :** Change in Knowledge Outcome Measure

2008 :1                      2009 : 1                      2010 : 1                      2011 :1                      2012 : 1

**3. Associated Knowledge Area(s)**

- 502 - New and Improved Food Products
- 511 - New and Improved Non-Food Products and Processes

**1. Outcome Target**

Number of opportunities and value-added programs introduced in Montana through continued education, research, and partnering

**2. Outcome Type :** Change in Action Outcome Measure

2008 :2                      2009 : 2                      2010 : 2                      2011 :2                      2012 : 2

**3. Associated Knowledge Area(s)**

- 502 - New and Improved Food Products
- 511 - New and Improved Non-Food Products and Processes

**1. Outcome Target**

Number of new products with value-added potential evaluated per year within Montana

**2. Outcome Type :** Change in Knowledge Outcome Measure

2008 :1                      2009 : 1                      2010 : 1                      2011 :1                      2012 : 1

**3. Associated Knowledge Area(s)**

- 502 - New and Improved Food Products
- 511 - New and Improved Non-Food Products and Processes

**1. Outcome Target**

Number of new food safety recommendations developed for consumers, which add value to Montana's agricultural products

**2. Outcome Type :** Change in Action Outcome Measure

2008 :2                      2009 : 2                      2010 : 2                      2011 :2                      2012 : 2

**3. Associated Knowledge Area(s)**

- 711 - Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources.

**1. Outcome Target**

New or expand business and/or partnerships created inside and outside of Montana

**2. Outcome Type :** Change in Condition Outcome Measure

2008 :1

2009 : 1

2010 : 1

2011 :1

2012 : 1

**3. Associated Knowledge Area(s)**

- 605 - Natural Resource and Environmental Economics

**V(J). Planned Program (External Factors)**

**1. External Factors which may affect Outcomes**

- Economy
- Appropriations changes
- Public Policy changes

**Description**

Inadequate moisture (rainfall, irrigation, snowpack) for crops to be produced and creating too much variability

Inadequate funding and technical support from partnering institutions and cooperators

Major interruptions in program development

Lack of full-time staff and part time assistants for the projects

Reduced support from Montana crop and animal agricultural groups, conservation and wildlife groups, private industry, private donations, and other agencies

**V(K). Planned Program (Evaluation Studies and Data Collection)**

**1. Evaluation Studies Planned**

- During (during program)
- Retrospective (post program)

**Description**

Evaluation studies will be conducted annually through the issuance of surveys, published peer review materials, and secured peer reviewed grant proposals.

**2. Data Collection Methods**

- Unstructured

**Description**

Data collection will be obtained through surveys at meetings, conventions, advisory boards, and by direct contact.

**V(A). Planned Program (Summary)****1. Name of the Planned Program**

Integrated Pest Management

**2. Brief summary about Planned Program**

Montana producers are asking for more environmentally friendly products or methods to control crop pests. Weeds, diseases, and insects continually challenge producers who are often producing crops under less than ideal conditions. Pesticides are a major expense to producers; however delaying or eliminating pest control measures may not always be an option. An increase in public concern about food quality, natural resource biodiversity, and sustainability of the quality of soil, air, and water is mandating less reliance on traditional pesticides and more research into biological control systems as part of a broader suite of management options. Foreign trade partners especially want decreased pesticide residues in the wheat and barley commodities being exported to their countries.

Research Activities: IPM programs in Montana seek to optimize grower profitability and natural resource sustainability through the development, selection, and implementation of economically sound and environmentally acceptable pest management strategies. Addressing the stakeholder's concern about pest control measures affecting food safety and food quality, MSU is continuing research into less chemically dependent systems. An emphasis on pest monitoring, using decision-making guidelines, and determining economic injury levels will continue to result in substantial economic benefits and optimize the use of pesticides for controlling pests.

Management of diseases of sugarbeets and potatoes has been a major focus of research and outreach education programs. Continuing research into novel disease management systems for potatoes will reduce a grower's dependence on a single management tool for protection of their crop. Understanding the role of weed diversity and seedbanks in Montana cropping systems will help producers develop more effective weed control programs. Herbicide screening trials will continue to be established to assess the effectiveness of new and existing herbicides under the range of environmental and crop conditions representative of Montana agricultural systems. Research is ongoing to find additional environmentally friendly solutions for the management of soilborne plant pathogens. Identifying optimal disease management strategies and establishing biological controls are priorities for producing potato, sugarbeet, small grains, and other crops in Montana. Increasing management for control of spotted knapweed will enhance rangeland productivity and plant diversity, while enhancing Montana's agricultural economic return and improving wildlife habitat.

**3. Program existence :** Mature (More than five years)

**4. Program duration :** Long-Term (More than five years)

**5. Expending formula funds or state-matching funds :** Yes

**6. Expending other than formula funds or state-matching funds :** Yes

**V(B). Program Knowledge Area(s)****1. Program Knowledge Areas and Percentage**

- 211 30% Insects, Mites, and Other Arthropods Affecting Plants
- 212 30% Pathogens and Nematodes Affecting Plants
- 213 20% Weeds Affecting Plants
- 215 20% Biological Control of Pests Affecting Plants

**V(C). Planned Program (Situation and Scope)****1. Situation and priorities**

In Montana, small grains represent about 73% of the cropped acres, alfalfa and other hay about 10%, and other crops 17%. Montana ranks 2nd in barley production in the U.S., 3rd in wheat production, and 5th in sugar beet production. Wheat and barley represent about 25% of the total agricultural receipts for the state. Montana producers are continually challenged to produce crops with limited resources, especially moisture. The addition of insect, disease and weed pests creates additional problems challenging producers to maintain a competitive position in the market. Producers have relied on traditional pesticides to economically reduce the direct impact pests have on food and fiber production. The pesticides are costly; however delaying or eliminating pest control options may not always be an option. Biological controls for insects, weeds, and diseases are becoming more important as traditional chemical control methods are under scrutiny or cancelled. The increase in public concern about food

quality, natural resource biodiversity, and sustainability of the quality of soil, air, and water is mandating less reliance on traditional pesticides and more research into environmentally friendly systems. Foreign trade partners especially want decreased pesticide residues in the wheat and barley commodities being exported to their countries. IPM programs seek to:

Address the economic feasibility and environmental impact of biological control practices.

Address the public's concern about food safety

Investigate crop rotation systems, crop production methods and water management

Implement biological control practices and explore a multitude of science-based options as a part of those systems.

Optimize grower profitability and natural resource sustainability

**2. Scope of the Program**

- In-State Research
- In-State Extension
- Integrated Research and Extension

**V(D). Planned Program (Assumptions and Goals)**

**1. Assumptions made for the Program**

Adequate moisture (rainfall, irrigation, snowpack) will be available for crops to be produced

Fulltime staff and part time assistants will be available to maintain appropriate progress

Funding and technical support will be maintained from partnering institutions and cooperators

Grain and livestock associations, chemical companies, and other agencies will continue to provide input and financially support priorities and activities

Program development will proceed as planned without major interruptions

**2. Ultimate goal(s) of this Program**

Contribute to the understanding of weed resistance through basic research that targets plant biochemical processes

Develop novel pest management systems that include biological control

Improve rangeland management by developing controls for exotic noxious weed species

Provide efficacious and cost effective pest control programs for producers

**V(E). Planned Program (Inputs)**

**1. Estimated Number of professional FTE/SYs to be budgeted for this Program**

Year	Extension		Research	
	1862	1890	1862	1890
2008	1.4	0.0	6.1	0.0
2009	1.4	0.0	6.1	0.0
2010	1.4	0.0	6.1	0.0
2011	1.4	0.0	6.1	0.0
2012	1.4	0.0	6.1	0.0

**V(F). Planned Program (Activity)**

**1. Activity for the Program**

Publications will be made available in print and online that provide pest control recommendations

Regional management guides will be produced and updated

Research results will be communicated through pesticide workshops and field days

Research results will be used to support FIFRA Section 18c products labeling requests

Results will be used to update pesticide applicator training materials

Training materials will be updated for private and commercial pesticide applicators

**2. Type(s) of methods to be used to reach direct and indirect contacts**

Extension	
Direct Methods	Indirect Methods
<ul style="list-style-type: none"> <li>● Workshop</li> <li>● Education Class</li> <li>● Demonstrations</li> </ul>	<ul style="list-style-type: none"> <li>● Newsletters</li> </ul>

**3. Description of targeted audience**

Crop producers, dealers, distributors and crop protection company representatives  
 Crop protection companies registration and research personnel  
 Montana crop advisory boards  
 Private and commercial pesticide applicators  
 State of Montana, Montana Department of Agriculture, BLM, USFS, and other government entities

**V(G). Planned Program (Outputs)**

**1. Standard output measures**

**Target for the number of persons(contacts) to be reached through direct and indirect contact methods**

	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Year	Target	Target	Target	Target
2008	250	150	0	0
2009	300	150	0	0
2010	350	150	0	0
2011	350	150	0	0
2012	375	150	0	0

**2. (Standard Research Target) Number of Patents**

**Expected Patents**

**2008 :1                      2009 :0                      2010 : 1                      2011 : 0                      2012 : 1**

**3. Expected Peer Review Publications**

Year	Research Target	Extension Target
2008	5	0
2009	5	0
2010	5	0
2011	5	0
2012	5	0

**V(H). State Defined Outputs**

**1. Output Target**

- Number of research citations

2008 :10                      2009 :10                      2010 : 10                      2011 :10                      2012 :10

- Multidisciplinary journal articles published

2008 :2                      2009 :2                      2010 : 2                      2011 :4                      2012 :4

**V(I). State Defined Outcome**

**1. Outcome Target**

Quality in-depth training programs for continuing educational on integrated approaches to pest management

**2. Outcome Type :** Change in Knowledge Outcome Measure

2008 :3                      2009 : 3                      2010 : 3                      2011 :3                      2012 : 3

**3. Associated Knowledge Area(s)**

- 211 - Insects, Mites, and Other Arthropods Affecting Plants
- 212 - Pathogens and Nematodes Affecting Plants
- 213 - Weeds Affecting Plants
- 215 - Biological Control of Pests Affecting Plants

**1. Outcome Target**

New IPM options discovered and evaluated per year

**2. Outcome Type :** Change in Action Outcome Measure

2008 :1                      2009 : 1                      2010 : 1                      2011 :1                      2012 : 1

**3. Associated Knowledge Area(s)**

- 211 - Insects, Mites, and Other Arthropods Affecting Plants
- 212 - Pathogens and Nematodes Affecting Plants
- 213 - Weeds Affecting Plants
- 215 - Biological Control of Pests Affecting Plants

**1. Outcome Target**

Number of broad-ranging stewardship practices implemented

**2. Outcome Type :** Change in Condition Outcome Measure

2008 :1                      2009 : 1                      2010 : 1                      2011 :1                      2012 : 1

**3. Associated Knowledge Area(s)**

- 211 - Insects, Mites, and Other Arthropods Affecting Plants
- 212 - Pathogens and Nematodes Affecting Plants
- 213 - Weeds Affecting Plants
- 215 - Biological Control of Pests Affecting Plants

**1. Outcome Target**

Passing rate percentage for pesticide application licenses

**2. Outcome Type :** Change in Knowledge Outcome Measure

**2008 :70                      2009 : 70                      2010 : 70                      2011 :70                      2012 : 70**

**3. Associated Knowledge Area(s)**

- 211 - Insects, Mites, and Other Arthropods Affecting Plants
- 212 - Pathogens and Nematodes Affecting Plants
- 213 - Weeds Affecting Plants
- 215 - Biological Control of Pests Affecting Plants

**1. Outcome Target**

New products registered

**2. Outcome Type :** Change in Condition Outcome Measure

**2008 :1                      2009 : 1                      2010 : 1                      2011 :1                      2012 : 1**

**3. Associated Knowledge Area(s)**

- 211 - Insects, Mites, and Other Arthropods Affecting Plants
- 212 - Pathogens and Nematodes Affecting Plants
- 213 - Weeds Affecting Plants
- 215 - Biological Control of Pests Affecting Plants

**1. Outcome Target**

Number of potential products/practices evaluated

**2. Outcome Type :** Change in Action Outcome Measure

**2008 :3                      2009 : 3                      2010 : 3                      2011 :3                      2012 : 3**

**3. Associated Knowledge Area(s)**

- 211 - Insects, Mites, and Other Arthropods Affecting Plants
- 212 - Pathogens and Nematodes Affecting Plants
- 213 - Weeds Affecting Plants
- 215 - Biological Control of Pests Affecting Plants

**V(J). Planned Program (External Factors)**

**1. External Factors which may affect Outcomes**

- Public Policy changes
- Appropriations changes
- Natural Disasters (drought,weather extremes,etc.)
- Government Regulations

**Description**

Inadequate moisture (rainfall, irrigation, snowpack) for crops to be produced and creating too much variability  
 Inadequate funding and technical support from partnering institutions and cooperators  
 Lack of fulltime staff and part time assistants for the projects  
 Major interruptions in program development

Reduced support from grain associations, biological and chemical pest control companies and other agencies

## **V(K). Planned Program (Evaluation Studies and Data Collection)**

### **1. Evaluation Studies Planned**

- After Only (post program)
- Retrospective (post program)

#### **Description**

Evaluation studies will be conducted annually through the issuance of surveys, published peer review materials, and secured peer reviewed grant proposals.

### **2. Data Collection Methods**

- Sampling
- Journals

#### **Description**

Data collection will be obtained through surveys at meetings, conventions, advisory boards and by direct contact.

**V(A). Planned Program (Summary)****1. Name of the Planned Program**

Plant Breeding, Genetics and Genomics

**2. Brief summary about Planned Program**

MSU is a recognized international leader in the development of new varieties of wheat and barley that are sought by buyers around the globe. An aggressive plant breeding program ensures development of higher yielding, disease- and insect-resistant wheat and barley cultivars. Researchers evaluate germplasm and identity traits that will produce higher quality wheat and barley to meet increasing demands for quality and for alternative uses, while maintaining yields. Many new cultivars are licensed with partnering companies, thus ensuring that Montana stakeholders receive maximum benefit from research discoveries. Additional work in the development of alternative crops continues to produce potential new market opportunities for Montana producers.

Research Activities: The development and distribution of high quality, drought tolerant barley varieties that provide the highest possible production potential is a priority of barley breeding programs. Research is being conducted on the development of lines for the malting, feed and ethanol industries. Our understanding has increased of the genetic control of traits like winter hardiness, feed quality, malting quality, and drought tolerance. Montana crop producers want improved hard red and hard white winter wheat cultivars that are adapted to Montana conditions and suitable for both domestic and export markets. Research is being conducted on winter wheat cultivars to develop germplasm with excellent end-use qualities and resistance to important environmental stresses. The research results will increase the competitiveness of Montana wheat producers through improved winter wheat varieties with enhanced yield potential, pest resistance, and end-use qualities. Researchers will evaluate more efficient screening, selection and breeding strategies and procedures to maximize efficiency and genetic progress in winter wheat breeding. Research projects will develop new hard red spring wheat varieties for Montana producers, contribute to the science of wheat breeding and genetics, and improve end-use characteristics.

Research studies examine the degree to which the puroindoline proteins control wheat grain hardness and cereal quality and what alterations can be made to generate desired milling and end-product quality. Further research will address the effects that modifying the starch biosynthetic pathway has upon grain hardness, milling quality, yield, and end product quality. Efforts have also been made to develop new grass varieties and a new sainfoin cultivar. The broader impacts of MSU research are a larger food supply for the world, an improved ability of Montana farmers to compete in a global marketplace, and a strengthening of export markets for U.S. wheat.

**3. Program existence :** New (One year or less)

**4. Program duration :** Long-Term (More than five years)

**5. Expending formula funds or state-matching funds :** Yes

**6. Expending other than formula funds or state-matching funds :** Yes

**V(B). Program Knowledge Area(s)****1. Program Knowledge Areas and Percentage**

- 202 45% Plant Genetic Resources
- 203 10% Plant Biological Efficiency and Abiotic Stresses Affecting Plants
- 204 45% Plant Product Quality and Utility (Preharvest)

**V(C). Planned Program (Situation and Scope)****1. Situation and priorities**

An aggressive plant breeding program ensures development of higher yielding, disease- and insect-resistant wheat and barley cultivars. Much of the North Dakota/Minnesota Red River Valley malting barley production is moving to Montana and Idaho, increasing the level of research needed to provide varieties suitable for Montana growing conditions. Additional work in the development of alternative crops continues to produce potential new market opportunities for Montana producers. Commercial buyers from Asian countries assess hard red spring wheats and hard red winter wheats for use in making noodles, steam bread, or loaves. Wheat cultivars developed at MSU and grown commercially by Montana producers continue to rank in the most preferred category by international customers.

Priorities in the Plant Breeding, Genetics, and Genomics Program Area include:

Increase yield potentials and maintain/improve quality

Improve winterhardiness, wheat stem sawfly resistance and imidazolinone herbicide tolerance

Integrate genomic research into breeding programs  
 Provide improved cultivars of small grains adapted to Montana climatic conditions and cropping systems

**2. Scope of the Program**

- Multistate Research
- In-State Research

**V(D). Planned Program (Assumptions and Goals)**

**1. Assumptions made for the Program**

Adequate moisture (rainfall, irrigation, snowpack) will be available for crops  
 Funding from industry organizations, grain and livestock associations, chemical companies, and other agencies will provide input into priorities and activities  
 Fulltime staff and part time assistants will be available to maintain appropriate progress  
 Funding and technical support will be maintained from partnering institutions and agricultural groups  
 Program development will proceed as planned without major interruptions

**2. Ultimate goal(s) of this Program**

Increase yield potential for small grain production in Montana  
 Maintain our role as a leading university in wheat and barley genetics research  
 Provide genomic research that will help Montana producers stay competitive  
 Provide improved cultivars of wheat and barley to Montana producers

**V(E). Planned Program (Inputs)**

**1. Estimated Number of professional FTE/SYs to be budgeted for this Program**

Year	Extension		Research	
	1862	1890	1862	1890
2008	0.0	0.0	4.8	0.0
2009	0.0	0.0	4.8	0.0
2010	0.0	0.0	4.8	0.0
2011	0.0	0.0	4.8	0.0
2012	0.0	0.0	4.8	0.0

**V(F). Planned Program (Activity)**

**1. Activity for the Program**

Communication of information on plant breeding and genomics advances through classroom activities, field days, variety trials, news releases, presentations at county and state meetings and conventions  
 Release germplasm, new varieties and new genomics tools and techniques  
 Strategic planning with state agricultural groups  
 Technical and non-technical publications

**2. Type(s) of methods to be used to reach direct and indirect contacts**

Extension	
Direct Methods	Indirect Methods
<ul style="list-style-type: none"> <li>● Demonstrations</li> </ul>	<ul style="list-style-type: none"> <li>● Public Service Announcement</li> <li>● Other 1 (Variety Recommendation Bulletins)</li> </ul>

**3. Description of targeted audience**

Domestic and foreign buyers of quality wheat  
 Farmers, colleagues, and stakeholders  
 Grain associations, Montana Department of Agriculture, Montana Wheat and Barley Committee, grain elevators and state commodity groups  
 Seed companies

**V(G). Planned Program (Outputs)**

**1. Standard output measures**

**Target for the number of persons(contacts) to be reached through direct and indirect contact methods**

	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Year	Target	Target	Target	Target
2008	2000	500	0	0
2009	2000	500	0	0
2010	2000	500	0	0
2011	2000	500	0	0
2012	2000	500	0	0

**2. (Standard Research Target) Number of Patents**

**Expected Patents**

**2008 :0                      2009 :1                      2010 :0                      2011 :1                      2012 :0**

**3. Expected Peer Review Publications**

Year	Research Target	Extension Target
2008	5	0
2009	5	0
2010	5	0
2011	5	0
2012	5	0

**V(H). State Defined Outputs**

**1. Output Target**

- Number of foreign trade teams in Montana

2008 :15                      2009 :15                      2010 : 15                      2011 :20                      2012 :20

- Number of foreign trade teams at MSU

2008 :4                      2009 :4                      2010 : 4                      2011 :4                      2012 :4

- Number of research citations

2008 :12                      2009 :14                      2010 : 16                      2011 :18                      2012 :20

**V(I). State Defined Outcome**

**1. Outcome Target**

Documents on new cultivars provided to Montana producers to maintain Montana producers' dominance in specialty grain markets

**2. Outcome Type :** Change in Knowledge Outcome Measure

2008 :100                      2009 : 100                      2010 : 100                      2011 :100                      2012 : 100

**3. Associated Knowledge Area(s)**

- 202 - Plant Genetic Resources
- 203 - Plant Biological Efficiency and Abiotic Stresses Affecting Plants
- 204 - Plant Product Quality and Utility (Preharvest)

**1. Outcome Target**

The number of new molecular techniques used to enhance breeding results

**2. Outcome Type :** Change in Action Outcome Measure

2008 :1                      2009 : 1                      2010 : 1                      2011 :1                      2012 : 1

**3. Associated Knowledge Area(s)**

- 202 - Plant Genetic Resources

**1. Outcome Target**

Average per bushel yield increase of Montana grains while maintaining product quality

**2. Outcome Type :** Change in Condition Outcome Measure

2008 :0                      2009 : 1                      2010 : 0                      2011 :1                      2012 : 0

**3. Associated Knowledge Area(s)**

- 204 - Plant Product Quality and Utility (Preharvest)

**1. Outcome Target**

Number of elite lines of wheat and barley screened for agronomic and quality characteristics

**2. Outcome Type :** Change in Knowledge Outcome Measure

2008 :100                      2009 : 100                      2010 : 100                      2011 :100                      2012 : 100

**3. Associated Knowledge Area(s)**

- 203 - Plant Biological Efficiency and Abiotic Stresses Affecting Plants
- 204 - Plant Product Quality and Utility (Preharvest)

**1. Outcome Target**

Number of improved variety recommendations by districts across Montana

**2. Outcome Type :** Change in Action Outcome Measure

2008 :5                      2009 : 5                      2010 : 5                      2011 :5                      2012 : 0

**3. Associated Knowledge Area(s)**

- 202 - Plant Genetic Resources
- 203 - Plant Biological Efficiency and Abiotic Stresses Affecting Plants

**1. Outcome Target**

Planted acreage percentage increase per year (base 2005) of MSU-released small grains in Montana

**2. Outcome Type :** Change in Condition Outcome Measure

2008 :3                      2009 : 3                      2010 : 3                      2011 :3                      2012 : 3

**3. Associated Knowledge Area(s)**

- 203 - Plant Biological Efficiency and Abiotic Stresses Affecting Plants
- 204 - Plant Product Quality and Utility (Preharvest)

**V(J). Planned Program (External Factors)**

**1. External Factors which may affect Outcomes**

- Other (Funding)
- Natural Disasters (drought,weather extremes,etc.)

**Description**

Inadequate funding and technical support from partnering institutions and cooperators  
 Inadequate moisture (rainfall, irrigation, snowpack) for crops to be produced and creating too much variability  
 Lack of fulltime staff and part time assistants for the projects  
 Major interruptions in program development  
 Reduced support from Montana crop and animal agricultural groups, conservation and wildlife groups, private industry, private donations, and other agencies

**V(K). Planned Program (Evaluation Studies and Data Collection)**

**1. Evaluation Studies Planned**

- Retrospective (post program)
- During (during program)

**Description**

Evaluation studies will be conducted annually through the issuance of surveys, published peer review materials and secured peer reviewed grant proposals. Additionally, information will be obtained from field days, conversations, direct input, and annual funding discussions with Montana Wheat and Barley Committee.

**2. Data Collection Methods**

- On-Site
- Unstructured

**Description**

Data collection will be obtained through surveys at meetings, conventions, advisory boards, and by direct contact.

**V(A). Planned Program (Summary)****1. Name of the Planned Program**

Sustainable Agriculture

**2. Brief summary about Planned Program**

Sustainability rests on the principle that we must meet the needs of the present without compromising the ability of future generations to meet their own needs. Researching new crops and finding new markets for existing crops are potential ways to enhance Montana's growth in sustainable agriculture. Farmers and ranchers in Montana have historically practiced sustainable activities due to the marginal opportunities for success in a semi-arid environment. Our priority to develop competitive, sustainable, and viable plant and animal systems for Montana stakeholders is reflected in the research.

Research Activities: To decrease Montana's primary dependence on small grains and forage crops, crop diversity studies are being conducted on the feasibility of growing a variety of crops including: pulse crops (pea, lentil, chickpea, soybean), herbs, mustard, safflower, sunflower, canola, turf, and specialty grains. The development of specialty crops and products for natural rubber production and bio-energy are a key focus.

Rangeland constitutes an important and widely variable resource for livestock producers. Studies are established to further define grazing parameters that maintain profitable agricultural enterprises while sustaining ecological systems. Most land managers agree that the spread of non-native invasive plants is a serious environmental threat to western wild lands. Research continues into the value of sheep grazing, which currently provides an economically feasible and ecologically sustainable tool to restore landscapes heavily infested with noxious weeds.

By the latter half of the 21st century, global warming could jeopardize agriculture, forestry, crop production, and other industries dependent on the natural environment. Studies are established to quantify nitrous oxide gas release under several cropping and tillage systems. Several projects over the past years have looked at flora growing in or near the hot springs of Yellowstone National Park. Understanding the mechanisms of growth of these native plants in geothermally-modified soils will help researchers understand the limitations and opportunities that global warming may present to agricultural production.

Our stakeholders charge us to improve animal health, food safety, quality, and marketing opportunities through sustainable practices. Two major initiatives address the needs of Montana livestock producers: the Montana Sheep Institute (MSI) and the Montana Beef Network (MBN). The objective of the MSI is to develop and implement nontraditional strategies that will increase the competitiveness of Montana lamb and wool in world markets. The MBN was established to return additional revenue to cattle producers and meet consumer needs in Montana. Consumers, both domestic and international, are demanding more information about the beef they purchase, including the age and source of the animal and the health, nutrition, and handling management. With the MBN in place, Montana producers can more easily adapt to mandatory country of origin labeling (COOL) and national animal identification programs.

**3. Program existence :** Intermediate (One to five years)

**4. Program duration :** Long-Term (More than five years)

**5. Expending formula funds or state-matching funds :** Yes

**6. Expending other than formula funds or state-matching funds :** Yes

**V(B). Program Knowledge Area(s)****1. Program Knowledge Areas and Percentage**

- 121 25% Management of Range Resources
- 132 10% Weather and Climate
- 205 15% Plant Management Systems
- 206 20% Basic Plant Biology
- 213 15% Weeds Affecting Plants
- 215 15% Biological Control of Pests Affecting Plants

**V(C). Planned Program (Situation and Scope)****1. Situation and priorities**

Montana is a rural state with a land area of 93 million acres and a population of 940,000. It has a strong crop and livestock industry with annual receipts of over \$3 billion. Small grains represent about 73% of the cropped acres, alfalfa and other hay about 10%;

other crops account for the remaining 17%. A basic principle of sustainable agriculture is to investigate current agricultural practices and find economically feasible and environmentally friendly alternatives to current agricultural practices. These include optimizing the use of chemicals for pest control, using alternative tillage systems, and increasing crop diversity. Goals of sustainable agriculture are to reduce dependence on non-renewable resources (such as fuel, synthetic fertilizer and pesticides), to promote stable and more prosperous farming communities, and to provide more farm income. With the continuing rise in fuel prices, farming practices that reduce dependence on fuel will add to the profitability of the enterprise. This factor alone provides incentives to farmers to investigate sustainable agricultural methods. The effects of MSU research in sustainable agriculture have an immediate impact on crop and livestock planning for Montana producers. A shift to more efficient and profitable specialty crops has begun and will continue to generate major interest in the future. The use of the Internet for information dissemination has become an increasingly valuable tool in providing stakeholders with materials to assist in their decision-making. While meetings, interviews, and focus groups will continue to be used to gather information from stakeholders, the increasing use of computer modeling and surveys will add to data being collected. As technology advances and producers begin to rely more on computer access to information, the role of MSU research and extension will continue to increase in their importance and impact.

MSU priorities are to:

Conduct research to determine the feasibility of growing a variety of crops including: pulse crops (pea, lentil, chickpea, and soybean), herb, mustard, safflower, sunflower, canola, turf, and specialty grains.

Decrease Montana's primary dependence on small grains and forage crops

Develop grazing recommendations for management of rangeland resources

Find ways through sustainable agriculture to provide more profitable farm enterprises

Promote stable and prosperous farm families and communities through the development of crop diversity and community agribusiness support

Reduce dependence on non-renewable resources (e.g., fuel, synthetic fertilizers, and pesticides) and maximize efficiencies

Research alternative pest control practices, including biological control for pests of forages, potatoes, small grains, and sugar beets.

## 2. Scope of the Program

- Multistate Extension
- In-State Extension
- Multistate Research
- In-State Research

## V(D). Planned Program (Assumptions and Goals)

### 1. Assumptions made for the Program

Adequate moisture (rainfall, irrigation, snowpack) will be available for crops

Fulltime staff and part time assistants will be available to maintain appropriate progress

Funding and technical support will be maintained from partnering institutions and cooperators

Grain and livestock associations, chemical companies, and other agencies will continue to provide input into priorities and activities

Program development will proceed as planned without major interruptions

### 2. Ultimate goal(s) of this Program

Determine practical rangeland grazing strategies for Montana livestock producers

Develop novel pest management systems for controlling insects, diseases, and weeds

Find and evaluate alternative sustainable fuel sources from agricultural products grown in Montana

Provide sustainable new cropping opportunities for Montana producers

## V(E). Planned Program (Inputs)

### 1. Estimated Number of professional FTE/SYs to be budgeted for this Program

Year	Extension		Research	
	1862	1890	1862	1890
2008	1.6	0.0	3.6	0.0
2009	1.6	0.0	3.6	0.0
2010	1.6	0.0	3.6	0.0
2011	1.6	0.0	3.6	0.0
2012	1.6	0.0	3.6	0.0

**V(F). Planned Program (Activity)**

**1. Activity for the Program**

Communicate research results through field days, news releases and presentations at county and state meetings and conventions  
 Distribute results of research via the Internet.  
 Hold strategic planning discussions with state agricultural groups

**2. Type(s) of methods to be used to reach direct and indirect contacts**

Extension	
Direct Methods	Indirect Methods
<ul style="list-style-type: none"> <li>● Education Class</li> <li>● Demonstrations</li> <li>● One-on-One Intervention</li> </ul>	<ul style="list-style-type: none"> <li>● Newsletters</li> </ul>

**3. Description of targeted audience**

Alternative energy groups and state agricultural advisory committees  
 Crop and livestock producers in Montana  
 Montana wheat and barley committees, crop protection companies, fertilizer advisory committees, conservation tillage equipment companies  
 Participants in extension and commodity group meetings and conferences

**V(G). Planned Program (Outputs)**

**1. Standard output measures**

**Target for the number of persons(contacts) to be reached through direct and indirect contact methods**

	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Year	Target	Target	Target	Target
2008	300	100	0	0
2009	400	125	0	0
2010	500	125	0	0
2011	600	150	0	0
2012	700	150	0	0

**2. (Standard Research Target) Number of Patents**

**Expected Patents**

2008 :0                      2009 :0                      2010 :0                      2011 :0                      2012 :0

**3. Expected Peer Review Publications**

Year	Research Target	Extension Target
2008	5	0
2009	5	0
2010	5	0
2011	5	0
2012	5	0

**V(H). State Defined Outputs**

**1. Output Target**

- Number of research citations

2008 :5                      2009 :5                      2010 :8                      2011 :8                      2012 :10

**V(I). State Defined Outcome**

**1. Outcome Target**

Number of strategic planning meetings with state groups and agencies

**2. Outcome Type :** Change in Knowledge Outcome Measure

2008 :10                      2009 : 10                      2010 : 10                      2011 :10                      2012 : 10

**3. Associated Knowledge Area(s)**

- 121 - Management of Range Resources
- 205 - Plant Management Systems

**1. Outcome Target**

Number of producers per year implementing new farm management and budgeting practices

**2. Outcome Type :** Change in Action Outcome Measure

2008 :100                      2009 : 100                      2010 : 100                      2011 :100                      2012 : 100

**3. Associated Knowledge Area(s)**

- 121 - Management of Range Resources
- 205 - Plant Management Systems

**1. Outcome Target**

Increased number of new crops adapted to Montana through percent acres increased

**2. Outcome Type :** Change in Knowledge Outcome Measure

2008 :5                      2009 : 5                      2010 : 5                      2011 :5                      2012 : 5

**3. Associated Knowledge Area(s)**

- 205 - Plant Management Systems

**1. Outcome Target**

Number of field days, news releases and presentations at conventions

**2. Outcome Type :** Change in Knowledge Outcome Measure

2008 :10                      2009 : 15                      2010 : 20                      2011 :25                      2012 : 30

**3. Associated Knowledge Area(s)**

- 121 - Management of Range Resources
- 205 - Plant Management Systems
- 213 - Weeds Affecting Plants
- 215 - Biological Control of Pests Affecting Plants

**1. Outcome Target**

Number of new producers per year adopting measures to improve agricultural efficiency (e.g. better seed quality, higher numbers of fields with soil tested, optimization of fertilizer use)

**2. Outcome Type :** Change in Action Outcome Measure

2008 :100                      2009 : 100                      2010 : 100                      2011 :100                      2012 : 100

**3. Associated Knowledge Area(s)**

- 121 - Management of Range Resources
- 205 - Plant Management Systems
- 213 - Weeds Affecting Plants
- 215 - Biological Control of Pests Affecting Plants

**1. Outcome Target**

Percent increase in acres per year of alternative crops compared to wheat and barley

**2. Outcome Type :** Change in Condition Outcome Measure

2008 :5                      2009 : 5                      2010 : 5                      2011 :5                      2012 : 5

**3. Associated Knowledge Area(s)**

- 121 - Management of Range Resources
- 205 - Plant Management Systems

- 213 - Weeds Affecting Plants
- 215 - Biological Control of Pests Affecting Plants

#### **V(J). Planned Program (External Factors)**

##### **1. External Factors which may affect Outcomes**

- Natural Disasters (drought, weather extremes, etc.)
- Appropriations changes
- Public Policy changes

##### **Description**

Inadequate moisture (rainfall, snowpack, irrigation) for crops to be produced creating too much variability

Inadequate funding and technical support from partnering institutions and cooperators

Lack of fulltime staff and part time assistants for the projects

Major interruptions in program development

Reduced support from Montana crop and animal agricultural groups, conservation and wildlife groups, private industry, private donations, and other agencies

#### **V(K). Planned Program (Evaluation Studies and Data Collection)**

##### **1. Evaluation Studies Planned**

- During (during program)
- Retrospective (post program)

##### **Description**

Evaluation studies will be conducted annually through the issuance of surveys, published peer review materials, and secured peer reviewed grant proposals.

##### **2. Data Collection Methods**

- Mail

##### **Description**

Data collection will be obtained through surveys, conventions, and advisory boards at meetings and by direct contact.

**V(A). Planned Program (Summary)****1. Name of the Planned Program**

Water Quality and Use

**2. Brief summary about Planned Program**

Montana is a headwater's state (Missouri River, and tributaries of the Snake, Yellowstone, and Columbia Rivers) with pristine waters that have scenic value, agricultural and manufacturing applications, and provide recreational opportunities for Montanans and visiting tourists. Montana is in a unique position to understand how land management practices impact ecosystems. Surface landscape practices, including agriculture, energy development, mining, and urbanization can severely impact both water quality and quantity. Evaluating watersheds to determine the best approach for raising crops, grazing livestock, and other uses will help protect riparian areas and improve our state's fisheries and wildlife habitat. Everyone in the state is impacted by water quality and quantity, whether it is managing reserves for agricultural production, for recreational use, or for daily consumption.

Research Activities: In order to provide sustainability to Montana producers and urban dwellers, several programs are in place to evaluate, monitor, and provide cropping and irrigation recommendations to agricultural and urban stakeholders. Research is continuing to better understand the relationship between alpine headwaters and valley bottom wetland systems to control streamflow quantity, runoff timing, and water quality. An understanding of the relationship between water runoff and land features is critical to developing better utilization of limited water resources. This knowledge aids not only crop and livestock producers, but those involved in city and county planning departments who must establish long-range plans for housing development, waste management, and water usage. Mapping soil water content for site-specific management of farm fields is commonly achieved through grid soil sampling. A new frequency domain approach to measure the static dielectric constant will facilitate measurements with very small probes. When this research is complete, investigators will be much closer to the routine estimation of specific surface area in soils for environmental and agricultural monitoring.

MSU is developing and delivering an online, experiential course in the science of water quality for secondary science teachers who may be struggling with other time commitments. The program will provide secondary science teachers with comprehensive water quality education; provide activities that are transferable to secondary science students, and provide rural, place-bound and distant students equal access to experiential water quality education. There is an increased interest in "native" landscaping; however native trees, shrubs, and perennial forbs planted with non-native grasses do not fit the palette for a totally native landscape. We are seeking to learn which native and adapted grasses are suitable for turfgrass applications, their water and mowing requirements, their potential to form a sod, and their ability to establish and/or restore a landscape. This program will reach those stakeholders who typically do not see results from major MSU research and outreach projects.

**3. Program existence :** Intermediate (One to five years)

**4. Program duration :** Long-Term (More than five years)

**5. Expending formula funds or state-matching funds :** Yes

**6. Expending other than formula funds or state-matching funds :** Yes

**V(B). Program Knowledge Area(s)****1. Program Knowledge Areas and Percentage**

- 111 30% Conservation and Efficient Use of Water
- 112 30% Watershed Protection and Management
- 610 10% Domestic Policy Analysis
- 903 30% Communication, Education, and Information Delivery

**V(C). Planned Program (Situation and Scope)****1. Situation and priorities**

Montana is a headwater's state with pristine waters that have scenic value, agricultural and industrial applications, and provide recreation for Montanans and visiting tourists. Stream flow, ground and surface water hydrology, fisheries and wildlife are heavily dependent on snow pack for the continuing adequacy of water supplies. A number of diverse ecological systems either border Montana or are located within the state. These systems provide opportunities for extensive research into how they behave under the climatic conditions and land use practices in Montana. As a semi-arid region, most irrigated crops are dependent on water either from streams or underground sources. Farmers are especially dependent on water reserves and stream flow to produce crops requiring greater water use. All Montanans are affected by decisions made to regulate water usage in the state. Research

information on water utilization and management in the Northern Rockies is very limited. Finding crops that require less water per acre and will grow in our short growing season requires innovative solutions. This is being partially accomplished through breeding programs, water management research, and the introduction of new drought tolerant crops. Research investigates alternative cropping systems and identifies ways to measure and predict water availability. Priorities include:

- Continue crop breeding investigations and changes in management practices
- Evaluate watersheds to determine the best approach for raising crops, grazing livestock and other uses to help protect riparian areas and improve the state's fisheries and wildlife habitat
- Finding crops that require less water per acre and that will grow in the shortened growing season
- Protect watersheds to ensure that water supplies are not interrupted due to inappropriate management

**2. Scope of the Program**

- Multistate Research
- In-State Research
- In-State Extension

**V(D). Planned Program (Assumptions and Goals)**

**1. Assumptions made for the Program**

- Adequate moisture (rainfall, irrigation, snowpack) will be available for the studies
- Conservation and wildlife groups, producers, and grain and livestock associations will continue to provide input into priorities and activities
- Drought may impact research results
- Fulltime staff and part time assistants will be available to maintain appropriate progress
- Funding and technical support will be maintained from partnering institutions and cooperators
- Program development will proceed as planned without major interruptions

**2. Ultimate goal(s) of this Program**

- Provide secondary education students with quality instruction by trained teachers in the understanding and protection of our water resources
- Provide soil water mapping tools with applications that lower costs of water and improve monitoring efficiency
- Provide stakeholders with a better understanding of the relationship between water runoff, land features, and land use practices

**V(E). Planned Program (Inputs)**

**1. Estimated Number of professional FTE/SYs to be budgeted for this Program**

Year	Extension		Research	
	1862	1890	1862	1890
2008	1.0	0.0	3.4	0.0
2009	1.0	0.0	3.4	0.0
2010	1.0	0.0	3.4	0.0
2011	1.0	0.0	3.4	0.0
2012	1.0	0.0	3.4	0.0

**V(F). Planned Program (Activity)**

**1. Activity for the Program**

- A new approach for mapping soil water content for site-specific measure will allow measurements with very small probes
- An online, experiential course in the science of water quality for secondary science teachers who may be struggling with other time commitments is developed
- Better utilization of limited water resources in Montana
- Research results will be communicated in meetings with key organizations who impact decisions on water quality and quantity in

Montana

Results from research will help to mitigate potential economic losses or disasters from inadequate or excessive water related events

**2. Type(s) of methods to be used to reach direct and indirect contacts**

Extension	
Direct Methods	Indirect Methods
<ul style="list-style-type: none"> <li>● Demonstrations</li> <li>● Workshop</li> <li>● One-on-One Intervention</li> <li>● Education Class</li> </ul>	<ul style="list-style-type: none"> <li>● Newsletters</li> <li>● Web sites</li> </ul>

**3. Description of targeted audience**

Organizations to be contacted include U.S. Geological Survey (USGS), National Resources Conservation Service (NRCS), the Montana Department of Natural Resources and Conservation (DNRC), irrigation districts, conservation districts and downstream and instream users

Secondary education science teachers

**V(G). Planned Program (Outputs)**

**1. Standard output measures**

**Target for the number of persons(contacts) to be reached through direct and indirect contact methods**

	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Year	Target	Target	Target	Target
2008	300	400	0	0
2009	350	400	0	0
2010	400	400	0	0
2011	450	400	0	0
2012	500	400	0	0

**2. (Standard Research Target) Number of Patents**

**Expected Patents**

2008 :0                      2009 :0                      2010 :0                      2011 :0                      2012 :0

**3. Expected Peer Review Publications**

Year	Research Target	Extension Target
2008	5	0
2009	5	0
2010	5	0
2011	5	0
2012	5	0

**V(H). State Defined Outputs**

**1. Output Target**

- Number of research citations.

2008 :12                      2009 :12                      2010 : 14                      2011 :14                      2012 :16

- Successful external grants

2008 :1                      2009 :2                      2010 : 2                      2011 :1                      2012 :2

**V(I). State Defined Outcome**

**1. Outcome Target**

Number of devices and models created for measuring the transport and fate of compounds

**2. Outcome Type :** Change in Knowledge Outcome Measure

2008 :1                      2009 : 0                      2010 : 2                      2011 :0                      2012 : 2

**3. Associated Knowledge Area(s)**

- 111 - Conservation and Efficient Use of Water
- 112 - Watershed Protection and Management

**1. Outcome Target**

Improved management systems for water quality and quantity

**2. Outcome Type :** Change in Action Outcome Measure

2008 :0                      2009 : 0                      2010 : 1                      2011 :1                      2012 : 0

**3. Associated Knowledge Area(s)**

- 111 - Conservation and Efficient Use of Water
- 112 - Watershed Protection and Management

**1. Outcome Target**

Educational programs that address water resource use

**2. Outcome Type :** Change in Condition Outcome Measure

2008 :2                      2009 : 2                      2010 : 2                      2011 :2                      2012 : 2

**3. Associated Knowledge Area(s)**

- 111 - Conservation and Efficient Use of Water
- 112 - Watershed Protection and Management

**1. Outcome Target**

Number of landscape scale datasets created

**2. Outcome Type :** Change in Knowledge Outcome Measure

2008 :1                      2009 : 0                      2010 : 2                      2011 :0                      2012 : 2

**3. Associated Knowledge Area(s)**

- 111 - Conservation and Efficient Use of Water
- 112 - Watershed Protection and Management

**1. Outcome Target**

Number of improved prediction capacity models for snowpack/runoff into rivers and for instream flow

**2. Outcome Type :** Change in Action Outcome Measure

2008 :0                      2009 : 0                      2010 : 1                      2011 :1                      2012 : 1

**3. Associated Knowledge Area(s)**

- 112 - Watershed Protection and Management

**1. Outcome Target**

Number of land and water use policies and practices developed by providing a scientific basis

**2. Outcome Type :** Change in Condition Outcome Measure

2008 :2                      2009 : 2                      2010 : 2                      2011 :2                      2012 : 2

**3. Associated Knowledge Area(s)**

- 610 - Domestic Policy Analysis

**V(J). Planned Program (External Factors)**

**1. External Factors which may affect Outcomes**

- Government Regulations
- Appropriations changes
- Natural Disasters (drought,weather extremes,etc.)
- Public Policy changes

**Description**

Inadequate funding and technical support from partnering institutions and cooperators  
 Inadequate input from conservation and wildlife groups, producers, and grain and livestock associations  
 Inadequate moisture (rainfall, snowpack, irrigation) to conduct the studies and creating too much variability  
 Interruptions in program development  
 Reduced numbers of staff and part time assistants to maintain appropriate progress on the project

**V(K). Planned Program (Evaluation Studies and Data Collection)**

**1. Evaluation Studies Planned**

- After Only (post program)
- Retrospective (post program)

**Description**

Evaluation studies will be conducted annually through the issuance of surveys, published peer review materials and secured peer reviewed grant proposals.

**2. Data Collection Methods**

- Sampling
- Journals

**Description**

Data collection will be obtained through surveys at meetings, conventions, advisory boards and by direct contact.